Engineering Library

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The Engineer.

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VOL. CXLVII.—No. 3812] LONDON: FRIDAY EVENING, FEBRUARY 1, 1929 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere road, Lambeth, London, S.E. 1, invites TENDERS for :—

SCHEDULE 1.—About 154 TONS FISH BOLTS with NUTS.

SCHEDULE 2.—62,248 METALLIC FILAMENT LAMPS for Train Lighting.

Tenders due as follows :—
Schedule 1, 11th February, 1929.
Schedule 2, 15th February, 1929.
Forms of Tender available from the above at a fee (which will not be returned) of 5s. for each Schedule. 883

Applications are INVITED for the PROFESSORSHIP of ELECTRICAL ENGINEERING at the COLLEGE of ENGINEERING, GUINDY, MADRAS. Candidates should not be more than 40 years of age. They must hold an Honours Degree in Electrical Engineering and have had practical experience in the design and execution of modern electrical plant and in the erection of heavy electrical machinery. Hydro-electric experience is also desirable.

Salary Rs. 1000 a month, rising by annual increments of Rs. 50 a month to Rs. 1500. Overseas pay of £25 a month admissible to officer of non-Asiatic domicile. Agreement for five years in first instance with possibility of extension. Free first-class passage to India for candidate and family. Strict medical examination.

Further particulars and form of application may be obtained upon request by postcard to the SECRETARY TO THE HIGH COMMISSIONER FOR INDIA, General Department, 42, Grosvenor-gardens, London, S.W. 1. Last date for receipt of applications 23rd February, 1929. 822

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.

APPLICATIONS from qualified candidates are INVITED for the following POSTS :—

M/959.—ASSISTANT WATERWORKS ENGINEER REQUIRED by the GOVERNMENT of NIGERIA for the Public Works Department for two tours of not less than 12 nor more than 18 months' service and possible extension. Salary £600, rising by annual increments to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates must have attained the age of 24 and must not be more than 35. They must have obtained an Engineering Degree at a recognised University or have passed Sections "A" and "B" of the A.M.I.C.E. examination, or the Associateship in Civil Engineering of the City and Guilds Institute, or possess such other Degree, Diploma or Distinction in Engineering as may be considered satisfactory. They must have had experience under a qualified civil engineer on the design of waterworks schemes, and preference will be given to those who have also had practical experience on the construction of such works with engineers or contractors.

M/1285.—ENGINEERING DRAUGHTSMAN REQUIRED by the GOVERNMENT of NIGERIA for service in the Harbour Department for two tours each of 12 to 18 months' service and possible extension. Salary £510, rising to £800 a year by annual increments. Free quarters and passages and liberal leave on full salary. Candidates, age 25 to 35, must be experienced in the design of reinforced concrete wharves and other structures, and should have had experience in the offices of a British Port or Harbour Authority.

M/1286.—RECORD DRAUGHTSMAN REQUIRED by the GOVERNMENT of the GOLD COAST for the Survey Department for two tours of 12 to 18 months' service and possible extension. Salary £480 for three years, then £510, rising by annual increments to £800 a year. Seniority allowance of £72 a year on attaining the salary of £720 a year. Free quarters and passages and liberal leave on full salary. Outfit allowance of £60 paid on first appointment. Candidates, age 27 to 35, must be capable of computing and plotting theodolite traverses. Must be experienced in enlarging, reducing and compiling plans and taking out areas. Should be experienced in plotting detail from field books and capable of checking data submitted by surveyors in the field.

M/746.—ASSISTANT TOWN PLANNING SUPERINTENDENT REQUIRED by the GOVERNMENT of the FEDERATED MALAY STATES for four years' service, with possible permanence. Salary 400 dollars, rising 800 dollars a month by annual increments of 25 dollars a month, plus an additional temporary non-pensionable allowance of 10 per cent. for bachelors and 20 per cent. for married men. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is considerably less than that of 2s. 4d. in the United Kingdom. No income tax is at present imposed by the Federated Malay States Government. Free passages are provided. Candidates, aged 23 to 30, must have received a good theoretical training in town planning at a University or School recognised by the Town Planning Institute of Great Britain or other such Diploma in Municipal Engineering and Surveying as the Secretary of State may consider adequate in any particular case. Must have a knowledge of surveying, experience in the preparation of municipal town planning and housing schemes. Site planning and replanning schemes for existing areas is desirable.

M/1313.—CIVIL ENGINEER REQUIRED by the MOSUL MUNICIPALITY in IRAQ for three years' service in the first instance. The rate of salary will depend upon the qualifications and experience of the officer selected, but will not exceed Rupees 1200 a month. Free passages. Candidates, about 25 years of age, must be fully qualified civil engineers and must have had extensive experience of water supply and electrical plant, also of roadmaking and maintenance and of town planning. Preference given to candidates who have had practical and responsible experience in one of the larger municipalities in the United Kingdom.

Apply at once by letter, stating age and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting the reference number against the appointment for which application is made. 861

Department of Scientific and Industrial Research.

JUNIOR ASSISTANT (ENGINEER) REQUIRED at the Fuel Research Station, East Greenwich. Candidates must have a good Honours Degree in Engineering or equivalent qualification, and preferably some research or practical experience. Scale of salary £175-15-£235 per annum plus Civil Service bonus; initial pay approximately £259. Superannuation provision will be made under the Federated Superannuation System for Universities.—Application should be made on a form to be obtained from the SECRETARY, Department of Scientific and Industrial Research, 16, Old Queen-street, Westminster, S.W. 1, to whom it should be returned not later than February 14th. 862

The Engineer

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PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 TO 1928.

Notice is Hereby Given that SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT m.b.H., a German Company, of 2, Rolandstrasse, Cassel-Wilhelmshohe, Germany, SEEK LEAVE to AMEND the SPECIFICATION of LETTERS PATENT No. 170,580, granted to them for an invention entitled "Improvements in and relating to Manhole Covers Suitable for Containers Under High Pressure."

Particulars of the proposed Amendment were set forth in the Illustrated Official Journal (Patents) of the 23rd January, 1929.

Any person, or persons, may give Notice of Opposition to the Amendment by leaving Patents Form No. 19 at the Patent Office, 25, Southampton-buildings, London, W.C. 2, within one calendar month from the date of the said Journal.

W. S. JARRATT,
P5438 Comptroller-General.

LONDON ASSOCIATION OF FOREMEN ENGINEERS
(FOREMEN, MANAGERS and EMPLOYERS)
connected with Engineering Industry.

Seventy-sixth Anniversary Festival,

CANNON STREET HOTEL,

SATURDAY, MARCH 2nd, 1929,

CHAIRMAN:
SIR FREDERICK D. GREEN.

Tickets 15/- each.

To be obtained from the SECRETARY, 36, GAYTON ROAD, HARROW. 746

PUBLIC NOTICES

Administrative County of LONDON.

APPLICATIONS are INVITED for the POSITION of DISTRICT INSPECTOR of SCHOOLS in the Education Officer's Department.

SALARY.—£500 a year, rising by annual increments of £25 to £600 and thence by annual increments of £50 to a maximum of £800 a year, with a fluctuating temporary addition. At the present time the total commencing salary is £659.

DUTIES.—To conduct and assist in conducting the inspection of schools, colleges, and institutes within the area and to inspect and to advise upon instruction in technical subjects. Candidates should possess engineering or similar technical qualifications as well as teaching experience. Apply to the Education Officer (C.1.), The County Hall, Westminster Bridge, S.E. 1. Stamped addressed envelope necessary for form of application, to be returned not later than 11th February, 1929.

Canvassing disqualifies.

MONTAGU H. COX,
717 Clerk of the London County Council.

County Borough of Hastings.
WATERWORKS.
TO BRITISH MANUFACTURERS OF CENTRIFUGAL DEEP WELL PUMPS OR ELECTRICAL PLANT.

The Corporation of Hastings invite TENDERS for the complete EQUIPMENT of an ELECTRICALLY DRIVEN PUMPING PLANT of British manufacture, to be installed in a bored well at Kent-street Pumping Station.

The works included in the contract consist of a turbine deep well pump driven direct by an electric motor, together with all electrical equipment and connections inside the building, and in accordance with drawings, general conditions, and specification prepared by the Engineer, Mr. Godfrey M. C. Taylor, of Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

The drawings, general conditions, specification and form of Tender may be obtained by the manufacturer at the office of the Engineer upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Tenders, in sealed envelopes, endorsed "Tender for Pumping Plant," must be delivered at my office at the Town Hall, Hastings, on or before Noon on Monday, the 25th day of February, 1929.

The Corporation do not bind themselves to accept the lowest or any Tender.

By Order,
(Sgd.) D. W. JACKSON,
Town Clerk.
Town Hall, Hastings. 856

PUBLIC NOTICES

Administrative County of LONDON.
GENERAL WORKS AND REPAIRS.

The London County Council invites TENDERS for the EXECUTION of GENERAL WORKS and REPAIRS (including JOBBING WORKS), exclusive of Works of a Mechanical Character, to SEWERS, ENGINE-HOUSES, BUILDINGS, BRIDGES, SUBWAYS, TUNNELS, &c., under the supervision of the Chief Engineer of the Council, on a schedule of prices for a contract for one, two, or three years, commencing 1st April, 1929.

Tenders are asked :—
(A) For the Whole of the Works on Both Sides of the River Thames ;
(B) For the Works on the North Side of the River Thames, but including Thames Bridges and Tunnels ;
(C) For the Works on the South Side of the River Thames only.

The schedule of prices, form of Tender, &c., may be obtained on application to the Chief Engineer, The Old County Hall, Spring-gardens, S.W. 1, upon payment of £3 by cheque, draft, or money order, to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

Remittances by post should be addressed to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, personal inquiries at Room 5a at No. 3, Warwick House-street, Cockspur-street, S.W. 1.

The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in "The London County Council Gazette."

No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 25th February, 1929, will be considered.

The Council does not bind itself to accept the lowest or any Tender.

MONTAGU H. COX,
844 Clerk of the London County Council.

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—
A. 1750 LAMINATED BEARING SPRINGS.
B. 1575 CARRIAGE and WAGON AXLE-BOXES and FITTINGS.
C. STEEL for SPRINGS.
D. 190,000 FISHBOLTS and NUTS.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Tuesday, 29th January, 1929.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Thursday, 7th February, 1929.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. C. VOLKERS,
840 Secretary.

Government of Northern IRELAND.
BANN DRAINAGE SCHEME.
NOTICE TO CONTRACTORS SPECIALISING IN THE DESIGN, MANUFACTURE AND ERECTION OF FLOOD GATES.

The Ministry of Finance invites DESIGNS and ESTIMATES of COST for the PROVISION and ERECTION of FLOOD GATES in Toome, Portna, and The Cutts Navigation Weirs on the Lower Bann River.

The accepted Design, with any amendments considered necessary by the Ministry, will be included in the contract for the drainage scheme.

The following are the approximate gate areas required :—

Toome Weir	3510 square feet
Portna Weir	1830 square feet
The Cutts Weir	1660 square feet

Plans, giving full particulars of the discharge capacities required at various levels of the river, maximum lift of gates, particulars of sites, cross and longitudinal sections, and particulars of nature of foundations, &c., can be obtained, on written application, from the Secretary, Ministry of Finance, 15, Donegall-square West, Belfast.

Applications for the plans should be accompanied by a deposit of £10, which will be repaid on return of the plans. Designs and Estimates should be forwarded to the Secretary, Ministry of Finance, not later than the 15th March, 1929.

R. E. THORNLEY,
Assistant Secretary.
Ministry of Finance, Belfast,
23rd January, 1929. 816

Royal State Railways of Siam
NOTICE.

Sealed TENDERS for the SUPPLY of SIX "GARRATT" LOCOMOTIVES and SPARE PARTS will be received by the SUPERINTENDENT OF STORES, Royal State Railways of Siam, Bangkok, Siam, until Fourteen o'clock on May 14th, 1929.

Blank Tender forms, general conditions and specifications, with requisite drawings, can be obtained from Messrs. Sandberg, of 40, Grosvenor-gardens, London, S.W. 1, upon payment of £2 per set, which sum will not be refunded.

Right is reserved to reject any or all Tenders. 869

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PUBLIC NOTICES

Metropolitan Water Board.

MAINS FOR THE IMPROVEMENT OF SUPPLY TO HENDON.

The Metropolitan Water Board invite TENDERS for the LAYING and JOINTING of the following CAST IRON MAINS, together with CONNECTIONS and contingent WORKS :—

2770 Lin. Yds. of 18in. dia. Main between Finchley-road and the North Circular Road ;
1875 Lin. Yds. of 18in. dia. Main between Brent-street and Holders Hill-road ;
1520 Lin. Yds. of 24in. dia. Main between the Vale, Hendon, and the North Circular Road ;
342 Lin. Yds. of 24in. dia. and 16in. dia. Main in Westbere-road and Mill-lane,

all in the Borough of Hampstead and the Urban District of Hendon, in the counties of London and Middlesex.

The drawings and contract documents may be inspected without charge at the offices of the Board, Chief Engineer's Department (Room 201).

Forms of Tender, conditions of contract, specification and bills of quantities, together with drawings and a spare copy of the bills of quantities may be obtained on and after Monday, 4th February, 1929, from the Chief Engineer, on production of an official receipt for the sum of £10, which must be deposited with the Accountant to the Board and which will be returned on receipt of a bona fide Tender accompanied by all the above-named documents and drawings (with the exception of the spare copy of the bills of quantities, which may be retained by the tenderer). Such payments and applications must be made between the hours of 10 a.m. and 4 p.m. (Saturdays, 10 a.m. and 12 noon). Cheques must be made payable to the Metropolitan Water Board and not to individuals.

Tenders, enclosed in sealed envelopes, addressed to the Clerk of the Board and endorsed "Tender for Mains for the Improvement of Supply to Hendon," must be delivered at the offices of the Board (Room 122) not later than 11 a.m. on Monday, 25th February, 1929.

The Board do not bind themselves to accept the lowest or any Tender.

G. F. STRINGER,
Clerk of the Board.

Offices of the Board,
173, Rosebery-avenue, E.C. 1,
22nd January, 1929. 775

State Electricity Commission

OF VICTORIA, AUSTRALIA.
22-32, WILLIAM-STREET, MELBOURNE, AUSTRALIA.

TENDERS are hereby INVITED for the MANUFACTURE, TESTING, SUPPLY, DELIVERY, ERECTION complete, PUTTING INTO SERVICE, and MAINTENANCE of the following PLANT for the Yallourn Power Station Extensions, in accordance with Specification 29/7, comprising :—

SECTION 1.—Steam Turbo-generators.
SECTION 2.—Condensing Plant, including Circulating Water Pumps.
SECTION 3.—Evaporating, De-aerating and Feed-heating Plant, including Boiler Feed Pumps.

Copies of Tender form, specification, drawings, &c., will be available upon application to the Agent-General for Victoria, Victoria House, The Strand, London, England.

Charge, £3 3s. for set of three copies of Tender form, conditions of tendering, specification, contract conditions and drawings complete. This charge is returnable under certain conditions as specified in the general conditions of tendering. Extra copies £1 1s. each, not returnable.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 29th April, 1929.

A preliminary deposit of £100 shall be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

R. LIDDELOW,
Secretary.

738

South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

SOLID-DRAWN STEEL BOILER TUBES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Solid-drawn Steel Boiler Tubes," with the name of the firm tendering, must be left with the undersigned not later than Twelve Noon on Friday, the 15th February, 1929.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 5s. for each copy of the specification.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.

A. MUIRHEAD,
Managing Director.

91, Petty France, Westminster, S.W. 1,
30th January, 1929. 882

The Bengal and North-Western RAILWAY COMPANY, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

	No.
DOG SPIKES ..... 100 TONS	
STEEL BOILER AND FLUE TUBES	7129
AXLES (Loco., Carr. and Wagon)	360
STEEL TYRES (Ditto)	1176
BUFFERS (Ditto)	624

as per specifications to be seen at the Company's Offices.

Tenders, addressed to the undersigned and marked "Tender for Dogspikes," or as the case may be, with name of firm tendering, to be lodged not later than Noon on Tuesday, the 19th day of February, 1929.

For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
W. R. IZAT,
Managing Director.

237, Gresham House, Old Broad-street,
London, E.C. 2, 30/1/1929. 863

Egyptian Government.

APPOINTMENT OF TWO SIGNAL INSPECTORS.

APPLICATIONS are INVITED for APPOINTMENT of TWO SIGNAL INSPECTORS in the Engineering Department of the Egyptian State Railways, Telegraphs and Telephones Administration.

Applicants must be of British nationality, between 25 and 40 years of age, preferably unmarried, and possess the following qualifications :—

Seven years' practical experience of Mechanical Signalling on an English Railway.

Practical experience with Westinghouse Company's 1905 and 1924 Interlocking Apparatus and thoroughly conversant with Locking Charts.

Must be able to fix any type of Facing Point Layouts, detected or otherwise, and arrange for correct compensation of point rodding.

Practical experience with the fitting up of Level Crossing Gates and Guillotine Barriers.

Salary £E 540-600 per annum, according to qualifications (£E 1 equals £1 0s. 6d. approximately), free of Egyptian income tax.

The appointment is subject to medical examination.

The selected candidate will be granted a transfer allowance equal to one month's salary for change of residence from England to Egypt and also vice versa.

Initial period of contract two years, subject to extension.

Third-class fares and reasonable out-of-pocket expenses will be paid to applicants who are requested to attend for interview and/or medical examination.

Application and specimen contract forms may be obtained from the

CHIEF INSPECTING ENGINEER,
Egyptian Government,
41, Tothill-street, London, S.W. 1,

to whom they should be returned with full particulars as to education, qualifications, previous experience, personal references, and COPIES of certificates or testimonials.

Envelopes to be endorsed "SIGNAL INSPECTOR."

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PUBLIC NOTICES

Swadlincote District and Ashby-de-la-Zouch Urban District Council.

JOINT WATER COMMITTEE.
TO CONTRACTORS.

The above-named Committee is prepared to receive TENDERS for the CONSTRUCTION of a SERVICE RESERVOIR of about 3 million gallons capacity and for the CONSTRUCTION of about 1600 YARDS of 15in. PUMPING MAIN and 1400 YARDS of 14in. SUPPLY MAIN, together with VALVES and other appurtenant WORKS, in accordance with the plans and specification prepared by the Engineers, Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

Contractors desirous of tendering can obtain copies of the general conditions, specification, bill of quantities and form of Tender from the offices of the Engineers upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Drawings may be inspected at the offices of the Engineers and also at the offices of the Committee, Ashby-de-la-Zouch.

Sealed Tenders, endorsed "Waterworks, Contract No. 1," must be delivered to the undersigned at the Clerk's Office, Ashby-de-la-Zouch, before Twelve Noon on Thursday, the 28th day of February, 1929.

The Committee does not bind itself to accept the lowest or any Tender.

By Order of the Committee,
(Sgd.) W. A. MUSSON,
Clerk to the Committee.

Clerk's Office,
Ashby-de-la-Zouch. 817

The Council of the Institution of Production Engineers

propose to APPOINT a full-time paid SECRETARY.

APPLICATIONS are INVITED from men with good organising ability, capable of administration and development, editing proceedings, &c. Knowledge of production engineering desirable, but not essential.—Written applications only will be considered, and should state age, experience, and salary required, in confidence, to the HON. SEC., 20, Lushington-road, London, N.W. 10, not later than February 12th, 1929.

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PATENTS AND DESIGNS ACTS, 1907 TO 1928.

BRAITHWAITE & Co. ENGINEERS LIMITED

of

BROADWAY BUILDINGS,
WESTMINSTER,
LONDON, S.W. 1,

Hereby Give Notice that their

Pressed Steel Cubic Tanks are protected by British Letters Patent No. 109546 of 1916, and they will take all necessary measures to safeguard their Rights thereunder.

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SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

A COMPANY Operating Commercial Aircraft INVITES APPLICATIONS for the POST of ASSISTANT to the CHIEF ENGINEER. Applicants should have had experience on the drawing-office, works management and inspection staffs of well-known aircraft and aircraft engine builders, experience in the maintenance and repair of Aircraft and Aircraft Engines, knowledge of A.I.D. requirements and procedure, and should be capable of taking charge in the Chief Engineer's absence.—Applications, giving full details of training and experience and stating age and salary required, should be addressed 841, The Engineer Office. 841 A

CONTRACTOR'S AGENT REQUIRED in Connection with the Construction of a Large Masonry Dam, Tunnel, &c., in the North of England.—Address, giving experience and references and stating salary required, P5404, The Engineer Office. P5404 A

ENGLISH FIRMS DESIRING First-class Energetic REPRESENTATION in Australia in engineering and associated lines, can procure same with firm of undoubted standing in Sydney. Excellent financial and selling record.—Write in first instance to Z.H. 251, care Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 584 A

ENGINEER (Heating and Ventilation). Practical and technologist. Capable estimating, planning and laying-out. Able to secure maximum efficiency on fuel consumption.—Apply, letter only, full particulars, BRANSTON ARTIFICIAL SILK CO., Ltd., Burton-on-Trent. 742 A

ENGINEER REQUIRED for South India ; Qualifications, first-class Structural and Mechanical Draughtsman with knowledge of Estimating and Designing and apprenticeship served with leading constructional firm. First agreement 5 years, first-class passages and outfit allowance paid. Healthy climate, good prospects. Age not exceeding 24.—Address, with full particulars, to 821, The Engineer Office. 821 A

FERRO-CONCRETE ENGINEER WANTED, Capable of designing Bridges for contract in South America. Spanish of advantage, but not essential.—Address, 879, The Engineer Office. 879 A

LONDON ENGINEERING WORKS REQUIRE LONDON REPRESENTATIVE with connection and able to secure orders for all kinds of Heavy Steel Plate Work, electrically welded and riveted.—Write, stating age, experience, and terms in confidence, to Box 248, Sells' Advertising Offices, Fleet-street, E.C. 4. 877 A

REQUIRED AT ONCE, WORKS MANAGER for London Constructional Steel Works, 150 men. Must be an eight o'clock man, experienced in economical and rapid production of first-class work, with thorough knowledge of costing, works lay-out, machinery and plant. State age, experience, and salary required.—Address, 850 The Engineer Office. 850 A

SALES ENGINEERS, with Knowledge of Compressed Air Machinery and Tools, WANTED for Midlands.—Apply, giving full particulars of qualifications, to ATLAS DIESEL CO., Ltd., 35, Surrey-street, Strand, W.C. 2. 851 A

STOREKEEPER for Small Engineering Works REQUIRED. State age, experience, and salary required.—Address, 839, The Engineer Office. 839 A

THE DIRECTORS of a Well-known and Old-established FIRM of PUMP MANUFACTURERS, having carried out works extensions for manufacture of Turbine Pumps, INVITE APPLICATIONS for POST of DESIGNING ENGINEER ; proposals will be considered only from persons who have held similar posts and are well equipped with the necessary technical and practical experience required for the design and economical production of this class of apparatus.

Please state age and salary required.

Applications to be endorsed "Centrifugal" and addressed 776, The Engineer Office.

Foreign publications please note. 776 A

WOOD TEMPLATE MAKER (First-class) ; Experience in Large Tank and Structural Work.—Write, stating age, experience, and salary required, and if at liberty, in confidence, Box 241, Sells, Fleet-street, London, E.C. 4. 878 A

WANTED IMMEDIATELY, DRAUGHTSMAN, with experience in Heavy Road Lorries, Steam and Oil.—Address, stating age, experience, and salary, 797, The Engineer Office. 797 A

SITUATIONS OPEN (continued)

WANTED, DRAUGHTSMAN, with Sound Knowledge and experience in the design of Electric Battery Loco. Trucks and Locomotives.—Address with full particulars of experience and salary required, 826, The Engineer Office. 826 A

WANTED IMMEDIATELY, a First-class DRAUGHTSMAN, with a thorough practical and theoretical knowledge of the design of Steel Structures for Electrical Overhead Transmission Lines. Good salary offered for right man.—Address in confidence, giving full particulars of experience with salary required, 825, The Engineer Office. 825 A

WANTED, MECHANICAL DRAUGHTSMAN, Preferably with experience in Cable Machinery. Give full details of experience, age, and salary required.—Address, 876, The Engineer Office. 876 A

WANTED, Thoroughly Capable DRAUGHTSMAN for old-established business in the Midlands manufacturing special high-class machines. Must have had practical shop experience with machine tools and experience in staff management. Age about 35. Good prospects.—Apply by letter only, giving age, full details of experience, and salary required, to "ENGINEER," c/o Wykes and Co., Chartered Accountants, Leicester. P5447 A

CENTRIFUGAL PUMP DRAUGHTSMAN, Capable Designer and Accurate Detailer of efficient pumps at competitive prices. Good job for the right man. Experience and previous employers, together with salary required, to be stated. Juniors not eligible.—Address, 608, The Engineer Office. 608 A

CHIEF DRAUGHTSMAN for Tool Room and Relieving Lathes ; only one who has real knowledge of these machines is required.

Good conditions and good salary are offered for this job in London.

Address, 544, The Engineer Office. 544 A

CHIEF DRAUGHTSMAN for Jig and Tool Drawing-office REQUIRED by a firm of Automobile Manufacturers in the Midlands. Applicants must have successfully held a similar position and have a good experience in modern manufacturing methods on a semi-production basis.—Address, stating age, experience, and salary required, 871, The Engineer Office. 871 A

DESIGNERS, with Experience in the Design of the latest type Heavy Motor Vehicle Chassis and Details, REQUIRED by a large firm in the South of England. Good positions to the right men.—Apply by letter, giving full particulars of experience, age, and salary required, &c., 750, The Engineer Office. 750 A

DRAUGHTSMEN, First-class Senior Men, REQUIRED, preferably with Aero-engine experience.—Write, stating age, full experience and salary required, to BRISTOL AEROPLANE CO., Ltd., Filton House, Bristol. 827 A

DRAUGHTSMAN, Mechanical or Electrical. Experience of Transformer or Electric Control Gear work an advantage.—Address, giving particulars of experience, age, and salary required, 831, The Engineer Office. 831 A

DRAUGHTSMAN (Not Junior) for Pumping Machinery, Reciprocating and/or Centrifugal.—Address, stating age, experience, salary required, 857, The Engineer Office. 857 A

DRAUGHTSMAN for Heavy Oil Engines, Land Type.—Address full particulars, age, and salary required, 858, The Engineer Office. 858 A

DRAUGHTSMAN REQUIRED for Works in Midlands. Must have experience in Chemical Plant design.—Address, stating age, experience, and salary required, 859, The Engineer Office. 859 A

DRAUGHTSMAN, Senior, with First-class Experience of Power Transformers.—Apply, stating age, experience, and salary required, to MANAGER, Drawing-offices, B.T.H. Co., Ltd., Rugby. 819 A

DRAUGHTSMAN WANTED for Confectionery Works in the North of England ; qualified in Automatic Machinery, Design and Lay-out Work. Age about 30.—Address, giving experience, salary required, and references, 843, The Engineer Office. 843 A

DRAUGHTSMAN WANTED ; LEADING CRANEMAN WANTED for works near Glasgow. State experience, age, and salary.—Address, 846, The Engineer Office. 846 A

EXPERIENCED DRAUGHTSMAN REQUIRED. Knowledge of Loom Design essential ; only fully qualified men with actual experience will be considered.—Address, 870, The Engineer Office. 870 A

FIRST-CLASS DRAUGHTSMAN WANTED for Tender Designs of Steam Breakdown Cranes.—Apply, stating age, experience, and salary required, to Box 1712, c/o Brown's, 30, Tothill-street, S.W. 1. 874 A

JIG AND TOOL DESIGNERS.—First-class MEN REQUIRED IMMEDIATELY. Shop experience. Knowledge of Small Arm Manufacture an advantage. Good opportunity for suitable applicants.—Write, giving details of experience, age, and salary required, to Box 62, Advertising Offices, 84, Queen Victoria-street, London, E.C. 4. 875 A

JIG and TOOL DRAUGHTSMAN REQUIRED as CHECKER by a firm of Motor Car Manufacturers in the Midlands. Only those experienced in this capacity should apply. State particulars of age, experience, and salary required.—Address, 872, The Engineer Office. 872 A

JUNIOR DRAUGHTSMEN REQD., Accustomed to detailing Steel-framed Buildings of all descriptions. State age, experience, and salary reqd.—Address, 855, The Engineer Office. 855 A

LADY TRACER WANTED for Engineer's Office, S.E. district.—Write, stating experience and salary, to Box 249, Sells' Advertising Offices, Fleet-street, E.C. 4. 881 A

MATERIAL HANDLING PLANT DRAUGHTSMAN REQUIRED, fully experienced in the preparation of Conveying Plant Detail and Structural Steel Works Designs.—Applications, giving full details of experience, age, salary required, and endorsed "Conveyor Draughtsman," should be addressed to the CHIEF ENGINEER, The Gas Light and Coke Co., Horseferry-road, S.W. 1. 880 A

MECHANICAL DRAUGHTSMAN (22-26) REQUIRED by large firm. One with sound technical training up to matriculation standard preferred.—Address, 833, The Engineer Office. 833 A

REQUIRED in London, a Capable STRUCTURAL and MECHANICAL DRAUGHTSMAN. Must be neat and accurate, and have had good experience in Chemical or similar Plant Lay-outs. Applicants should state age, experience, wages required, and when at liberty.—Address, P5437, The Engineer Office. P5437 A

REQUIRED, SEVERAL First-class DRAUGHTSMEN, with Aeronautical experience ; also TWO or THREE First-class MECHANICAL MEN. Good salary and overtime pay to suitable applicants. Give concise details of experience, salary required, &c., and when at liberty, to Messrs. THE BLACKBURN AEROPLANE and MOTOR CO., Ltd., Brough, E. Yorks. 752 A

STRUCTURAL STEEL WORK.

ONE or TWO SENIOR DRAUGHTSMEN, with good experience of the design and detail of Steel-frame Buildings in London, also preferably Theatre experience. Able to design and detail from architects' plans on own responsibility, including necessary site surveying. State salary required.—Applications only by letter to CHIEF DRAUGHTSMAN, Smith Walker, Ltd., 16, Caxton-street, Westminster, S.W. 1. P5436 A

SITUATIONS OPEN (continued)

STRUCTURAL DRAUGHTSMEN WANTED, Manchester district, used to detailing all kinds of Steel Structures. Good pay for suitable men. State age, experience, and salary required.—Address, 824, The Engineer Office. 824 A

STRUCTURAL STEEL WORK DRAUGHTSMAN REQUIRED in the Midlands. Must be thoroughly experienced in design of Large Steel Work Structures. Wages £7 to £8 per week, according to experience.—Address applications, giving full particulars as to age, training, experience and enclosing copies of recent testimonials, 842, The Engineer Office. 842 A

THE CHATWOOD SAFE CO., Ltd., Shrewsbury, have a VACANCY for a well-trained JUNIOR MECHANICAL DRAUGHTSMAN.—Apply, "TECHNICAL DIRECTOR," giving age, qualifications, and salary required. 834 A

FOREMAN or WORKS MANAGER for Old-established Firm of Engineers' Brassfinishers making steam fittings. Practical experience in this line and thorough knowledge latest methods of production essential.—Address fully, stating remuneration expected, 860, The Engineer Office. 860 A

FOREMAN REQUIRED for Machine Shops by Large Engineering Firm in the Midlands. Applications will only be considered from persons with extensive Machine Shop experience, capable of control, and good management. State age, firms worked for, class of machines.—Address, 845, The Engineer Office. 845 A

TOOL ROOM FOREMAN.—A GENERAL ENGINEERING FIRM in the Midlands REQUIRE the SERVICES of a capable ENGINEER to fill the above position. Preference will be given to a technically trained man, of wide experience, between the ages of 35 to 40.—Address, stating age, fullest details of experience and previous positions held, and remuneration required, 788, The Engineer Office. 788 A

DREDGE ERECTOR.—WANTED, Capable ERECTOR for Gold Dredge (abroad).—Write, stating experience, age, salary required, Box 290, Sells' Advertising Offices, Fleet-street, E.C. 4. 868 A

SITUATIONS WANTED

A SECRETARY SHORTHAND TYPIST, Some Years' engineering experience, all-round office routine and good knowledge German, SEEKS really RESPONSIBLE POST.—Address, P5429, The Engineer Office. P5429 B

AN ENGINEER of Exceptional Varied and Practical experience and of proved inventive ability, OFFERS his SERVICES. First-class designer and draughtsman. Used to intricate machinery. Competent to develop schemes, &c. First-class Engineering Diplomas. Fluent French. Highest references.—Address, P5426, The Engineer Office. P5426 B

CONTRACT Terminating Abroad, ENGINEER (41) REQUIRES POST. Experienced mech., constructional, contractors, railway works, comm. works, and dept. management.—Address, P5373, The Engineer Office. P5373 B

ENGINEER, Age 25, SEEKS APPOINTMENT, home or abroad, charge Diesel electrical plant. Previous experience complete charge engines up to 750 H.P., knowledge Spanish.—Address, P5445, The Engineer Office. P5445 B

ENGINEER DESIRES POSITION as Works Manager or Chief Inspector ; 25 years' exp. drawing-office and works, aero, automobile and general engineering.—Address, P5448, The Engineer Office. P5448 B

ENGINEER, Eleven Years' Canadian, Five Years' Indian, and two years' Australian experience in all classes civil engineering construction, SEEKS POSITION at home or abroad.—Communicate in first instance, P5443, The Engineer Office. P5443 B

ENGINEER (29) SEEKS RESPONSIBLE POSITION ; public school education, experienced D.O. and assistant engineer, works extensions and maintenance.—BM/L024, London, W.C. 1. P5449 B

ENGINEER (25), Graduate Mech. Eng., REQUIRES POST. Two years' experience on colliery plant, two years DRAUGHTSMAN, mining machinery.—Address, P5441, The Engineer Office. P5441 B

ENGINEER (31), First Class Board of Trade Steam and Diesel Certificates, DESIRES POSITION of TRUST ; 9 years' sea service, 2½ years second and chief engineer, "Krupp" Diesel engines. Highest references.—Address, P5421, The Engineer Office. P5421 B

ENGINEER (36), with Works, D.O., and Managerial experience in steam, power plant, refrigerating and motors, DESIRES POST. Moderate salary if future prospects.—W. S., 218, King's-road, Kingston-on-Thames. P5432 B

EXTRA FIRST-CLASS ENGINEER, with First Diesel endorsement, DESIRES RESPONSIBLE POST ashore. Experienced turbines, recip. and Diesel engines, turbo auxiliaries, &c.—Address, P5444, The Engineer Office. P5444 B

G.I. MECH. E. (Age 23), 2 Years Shops, 5 Years D.O., SEEKS responsible progressive POSITION as Assistant Engineer, Korea, energetic and accustomed to responsibility.—Address, P5439, The Engineer Office. P5439 B

MECHANICAL ENGINEER (39), Public School, full practical and commercial experience, REQUIRES responsible POST very urgently in works or commercial concern. London area preferred. No reasonable offer refused. Excellent references.—Write, Box W. 358, Willing's, 86, Strand, W.C. 2. 791 B

QUALIFIED ENGINEER, Well Educated, Full Shop training followed by theoretical course, just returned from abroad on completion of contract, DESIRES POSITION of RESPONSIBILITY. Has had many years' experience in mechanical, electrical engineering, heavy erection work abroad, design, construction and operation of extra high-pressure steam plants, electrification of mechanical plants and some commercial experience. Fluent German and French.—Address, P5431, The Engineer Office. P5431 B

TRAVELLER REPRESENTATIVE in Engineering Goods, 20 years' experience. Salary required £400 p.a. or near offer.—Address, P5434, The Engineer Office. P5434 B

WELL-EDUCATED YOUTH (19), Matric., SEEKS POSITION as PUPIL ASSISTANT to Civil, Mechanical or Electrical Engineer in London district. Premium.—WHITE, 5, Manville-road, S.W. 17. P5435 B

WORKS MANAGER, with Wide Machine Shop, foundry and general works practice. Expert costing and stores systems ; excellent production record with low costs ; WANTS a CHANGE.—Address, P5456, The Engineer Office. P5456 B

WORKS MANAGER, General Engineering, SEEKS similar or executive POSITION, technical or commercial ; age 36, married ; varied British and continental experience. Mod. salary.—Address, P5451, The Engineer Office. P5451 B

KEEN, Smart Young LADY REQUIRES SITUATION as TRACER at home or abroad ; 10 years' good experience in mechanical and architectural work.—Address, P5446, The Engineer Office. P5446 B

For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Report of the Bridge Stress Committee.

THE report of the Bridge Stress Committee of the Department of Scientific and Industrial Research is being published to-day, Friday. The Committee was appointed in March, 1923, "to conduct researches with reference to the stresses in railway bridges, especially as regards the effects of moving loads." It was presided over by Sir J. A. Ewing, and included, among its nine other members, representatives of the four railway groups. The report, obtainable through H.M. Stationery Office, price 18s. net, is an extensive document, containing many diagrams and tables. It is very doubtful whether any summary of it would prove useful to our readers, for it is essentially a work which should be consulted in the original. In our next issue we hope to present a synopsis of its contents, which will be sufficiently detailed to enable our readers to form a picture of the ground covered by the report. A few notes concerning the findings of the Committee are given elsewhere in this issue in our summary of the annual report of the Department of Scientific and Industrial Research.

Launch of H.M.S. Dorsetshire.

AT Portsmouth on Tuesday the launch took place of H.M.S. "Dorsetshire," the eleventh and last of the 10,000-ton cruisers laid down for the Royal Navy since the Washington Conference. This vessel, with her sister ship "Norfolk," which went afloat from the Fairfield Company's yard at Govan on December 12th, constitutes a new class, differing in minor but not unimportant respects from the five "Kents" and the four "Londons." The "Norfolk" group would probably have numbered four units but for the deletion of two 10,000-ton cruisers from the quinquennial building programme, one being dropped in 1927 and the other from the 1928 Navy Estimates. A ship of the same, or perhaps an improved, class is projected for 1929–30. Authorised in the Estimates for 1926, the "Dorsetshire" was begun on September 21st, 1927, and has thus been over sixteen months on the slipway. She has an extreme length of 633ft., a beam of 66ft., and a mean draught of 16½ft., the standard displacement being 10,000 tons. Her steam turbine machinery, built by Cammell Laird and Co., develops 90,000 S.H.P., the contract speed being 32 knots. Yarrow type boilers are installed. For cruising purposes the vessel is equipped with internal-combustion engines, the design and power of which have not yet been disclosed. The fuel-oil capacity is 3400 tons, sufficient for a voyage of 10,400 miles at speeds between 11 and 14 knots. No bulges are fitted to the hull, but their omission, it is understood, has been compensated for by improved methods of internal subdivision. Like her immediate forerunners of the "London" group, the "Dorsetshire" will carry a seaplane, together with catapult projecting gear and twin derricks for hoisting the machine inboard. The armament, eight 8in. turret guns, four 4in. A.A., and eight torpedo tubes on quadruple mountings, is similar to that of the earlier "County" ships.

The New Engineer-in-Chief, Great Western Railway.

AT their meeting on Friday last the directors of the Great Western Railway Company appointed Mr. Raymond Carpmael, M. Inst. C.E., to the position of engineer-in-chief in succession to the late Mr. J. C. Lloyd. Mr. Carpmael has been connected with the company since March, 1900, when he joined the engineer's department under the late Mr. James C. Inglis, going, the following year, to Fishguard in connection with the new harbour and the additional lines there. In 1909 he went to Shrewsbury and afterwards to Gloucester as chief assistant to the respective divisional engineers, and during the war he was for a time in France as senior engineer in charge of the civilian permanent-way corps. In 1919 Mr. Carpmael was made the divisional engineer at Shrewsbury and in 1922 was removed to a similar position at Neath, and then came to London in February, 1924, to be an assistant to the chief engineer, becoming assistant engineer in January, 1926. That office he now vacates on his promotion.

The Proposed National Industrial Council.

THE interim joint report adopted last July by the Melchett-Turner Conference on Industrial Reorganisation and Industrial Relations contained a proposal for the establishment of a National Industrial Council consisting of representatives of the General Council of the T.U.C. and an equal number of employers' representatives nominated by the Federation of British Industries and the National Confederation of Employers' Organisations. The duties of the proposed Council were to consist of holding regular quarterly meetings for general consultation on questions of industry and industrial progress, to establish and direct machinery for continuous investigation into industrial problems and to establish a Standing Joint Committee for the appointment of Joint Conciliation Boards. The Council of the British Engineers' Association has considered the Conference's interim report in the light of the response made by members of the Association to a request for an expression of their views on the proposed National Industrial Council. The Council of the Association has now published a statement in which it summarises its objections to the establishment of the proposed National Industrial Council. It holds that the General Council of the T.U.C., while fitted to deal with labour questions, is not necessarily competent to discuss the wide range of industrial, economic, commercial and financial matters which it is suggested the National Industrial Council should consider. It is, further, definitely associated with the Labour Party, whereas the employers' organisations are organised on a completely non-political basis. The extremely varied and difficult questions suggested for the consideration of the National Industrial Council are in many cases held to be subjects on which that Council would be more fitted to receive evidence and instruction from experts than to pronounce an opinion. Among other objections to the proposed Council urged by the British Engineers' Association is the fact that it would be representative of less than four millions out of the twelve million insured persons engaged in industry and trade. Non-union labour and unaffiliated trade unions would not be represented on the Council.

A Motor Vessel for Cross-Channel Service.

ON Thursday of last week, January 24th, Harland and Wolff, Ltd., launched from their South Yard at Belfast the twin-screw motor vessel "Ulster Monarch," the first of three ships for the Belfast-Liverpool service of the Belfast Steamship Company, Ltd., now to be known as the Ulster Imperial Line. The other two ships, the "Ulster Queen" and "Ulster Prince" are well advanced, and the new motor vessels will replace the present steamers "Patriotic," "Heroic," and "Graphic" during the year. The "Ulster Monarch" is the first cross-Channel motor vessel to be built for British use, and she is distinctive alike in her appearance, her accommodation, and her propelling machinery. She has a length of 350ft. between perpendiculars, with a breadth moulded of 46ft., and a depth moulded of 19ft. Her gross tonnage is about 3760. She has a cruiser stern and two of the distinctive funnels which we associate with Harland and Wolff-built motor vessels. Accommodation is provided for 419 first-class passengers in single and two-berth state rooms, and for 88 third-class passengers in two and four-berth rooms. The public room will be well appointed, and many new and useful features are to be introduced. The main propelling machinery comprises a twin-screw arrangement of ten-cylinder trunk piston Harland B and W oil engines. Each engine will have a designed output of 3000 S.H.P. at a normal running speed of 160 r.p.m. The cylinders are 630 mm. bore with a stroke of 980 mm. They will be of the four-stroke single-acting type, operating on the airless injection system. As the route is one on which much manœuvring requires to be done, special attention has been paid to the design of the air compressors and storage receivers utilised for starting and manœuvring the engines. Both the deck and engine-room auxiliary machinery will be electrically operated, and the electric power and light for the ship will be supplied by three six-cylinder airless injection generator sets. Arrangements are made whereby the boiler supplying steam for the ship's use can be fired either by oil fuel direct or heated by the exhaust gases from the main engines.

New Italian Warships

A NEW Italian naval programme was officially announced at Rome on Friday last. It comprises the following ships, all of which are to be laid down next June:—Two 10,000-ton cruisers, two 5500-ton cruisers of the "Condottiere" class, four destroyers, and five submarines. These vessels, it is stated, will aggregate 37,000 tons, and their cost is estimated at £9,000,000. As Italy already has two 10,000-ton cruisers, "Trento" and "Trieste," in commission, with two similar ships and four of the "Condottiere" class on the stocks, the additions now to be made will eventually give her a fleet of twelve post-war cruisers, six of them being of the 10,000-ton, 8in. gun type. France, up to the present, has built or legislated for six 10,000-ton and three 8000-ton cruisers. Thanks to this impending batch of new contracts the Italian shipyards will be well supplied with naval work for some time to come At present the Stabilimento Tecnico, of Trieste, is building the 10,000-ton cruiser "Fiume." The Odero Terni Yard, at Spezia, has in hand a sister ship, "Zara," besides two 2000-ton and two 1450-ton destroyers, and two 850-ton submarines. Castellamare Dockyard is working on the 5500-ton cruiser "Bande Nere," and the Ansaldo Company, of Sestri Ponente, on three similar cruisers, "Colleoni," "da Barbiano," and "da Giussano," and two 2000-ton destroyers. On the stocks at the Monfalcone establishment are six large submarines; two further submarines are being built at the Tosi Yard, Taranto; four destroyers by the Tirreno Yard, at Riva Trigoso; four at the Quarnaro Works, and two at the Riuniti Yard, Ancona. Although some of these vessels will be launched before June, the fact remains that the Italian shipbuilding industry during the next two or three years will be engaged in the construction or completion of forty-five vessels of war, from cruisers to submarines.

Government Assistance to Scientific Workers.

THE latest report issued this week by the Department of Scientific and Industrial Research enables us once again to study the distribution of grants from the Department to students and research workers in the various branches of science. It is noticeable that in the two categories, students' maintenance allowances and personal grants to research workers and research assistants, the aggregate number of grants shows a decided tendency to diminish each year. As usual, the greatest number of grants during 1927–28 fell to the lot of the chemists, of whom 82 students and 10 research workers were benefited. As usual, too, physics, with 27 and 8 respectively, came second, and biology, with 16 and 5, third. Ten students and 1 research worker in engineering received grants. In mathematics and astronomy the grants numbered 7 and 1, in metallurgy 5 and 1, and in geology and mineralogy 2 and 3. In another table in the report particulars are given of the after careers of 165 students in training to whom allowances were made in the year 1926–27. Of these students 59 had their grants renewed, 35 took up industrial research posts, 26 were appointed to scholarships, 17 obtained university posts, 10 took up scholastic work, 9 entered the Government scientific service, 4 engaged on unaided research work, and 5 are classified as miscellaneous.

The Demolition of the Cofton Tunnel.

THE work of demolishing the Cofton Tunnel on the Birmingham line of the London, Midland and Scottish Railway near Barnt Station, was successfully completed during last week-end, when the final length of 140 yards which remained from the original 440-yard tunnel, was blown up, and the *débris* cleared away during a temporary stoppage of the train services. The work of demolition and the excavation of the new cutting, which, when completed, will be one of the largest in Great Britain, has been going on for nearly three years. Towards the end of last week the covering of earth and rock over the tunnel was completely removed, and preparations for shot firing were made. The tunnel was brought down in three sections by a number of small charges, which were fired simultaneously by electric means. The ordinary rail services were suspended shortly after ten o'clock on Saturday evening, and the tunnel was blown up late on Saturday night. About 200 men and 150 empty wagons were in readiness, and the *débris* was so quickly removed that the railway services were resumed on Monday morning. Although the main line is now clear of the tunnel covering, much remains to be done before the new double track can be laid down. On the east side of the tunnel a wall of rock some 25ft. wide with a depth of 12ft. has to be cut away, and other preparatory work done before track-laying operations can be begun. The work is being carried out by Logan and Hemingway, Ltd., of Doncaster, under contract, and Mr. John Dickson is the resident engineer in charge.

The Vibrations of Roads and Structures.

ON Tuesday evening last, the paper recently read before the Institution of Civil Engineers by Mr. J. H. Hyde and Mr. H. R. Lintern, of the National Physical Laboratory, on "The Vibrations of Roads and Structures," was again presented for further discussion. This paper comes at a particularly opportune time, since it deals with the vibrations which obtain in roads and structures, and are caused by modern vehicular traffic and machinery, a subject which is now engaging the attention of many architects and civil and road engineers. The authors have carried out experiments with recording instruments, which have enabled them to measure the amplitude and periodicity of the vibrations of the ground which are set up by such causes as a falling weight, stationary engines and machines, the passage of heavy motor vehicles over definite obstacles and ordinary roads, and the passage of an electric train. The vibrations were found to vary in their transmission, according to the state of consolidation of the ground. It was established that the frequency of vibration of a road surface was greatly increased when the load carried placed abnormal stress on the rubber tire. When the wheel dropped into a pot-hole, especially when such a hole was preceded by a projection on the road surface, vibrations of considerable amplitude were set up. There was little trace of the effect of out-of-balance engine forces in the records obtained, and the principal vibrations caused by electric trains were the direct outcome of the passage of the wheels over the rail joints. The experiments, though interesting and valuable, do not appear to have furnished data from which definite conclusions may be drawn as to the destructive effect of vibration on the fabric of a structure.

Automatic Weighing Machines.

No. II.*

Compensating Device.

It will be appreciated that the ideal to be sought in the design of an automatic weighing machine is to secure the instantaneous stoppage of the flow of material into the bucket when the beam reaches the horizontal position, to make the beam and bucket reach that position with zero velocity, to deliver the last dribble of material into the bucket without sensible momentum, and to ensure that when the beam reaches the horizontal position it is acted upon by no force other than that of the weight box at one end and the charged bucket at the other.

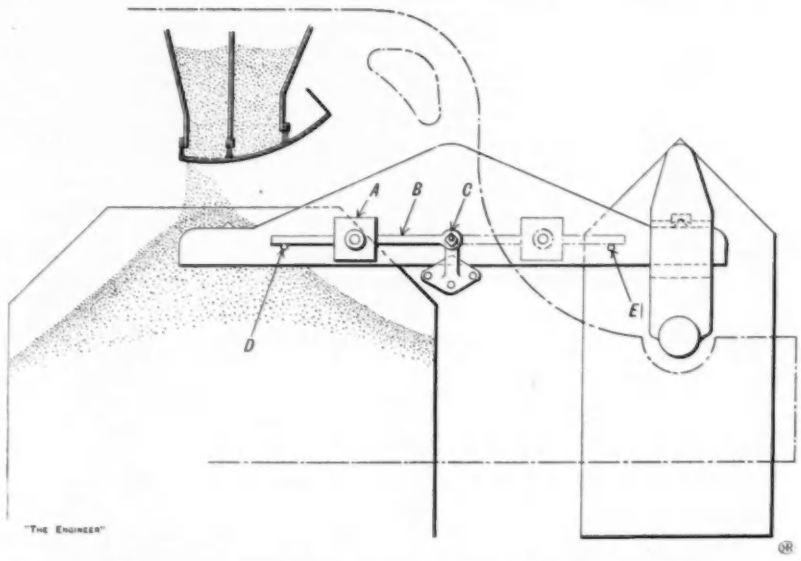

FIG. 6—COMPENSATING DEVICE ON "REFORM" AUTOMATIC WEIGHER

In practice, it is impossible to realise this ideal. When the beam of the "Reform" automatic weigher reaches the horizontal position, the lower end of the bucket hanger makes contact with the trip trigger, and consequently the beam in this position is acted upon by the friction and resistance of that trigger. Again, a perceptible interval occurs between the instant when contact is made with the trip trigger and the instant when that trigger has moved sufficiently to release the falling arm. Another perceptible interval occurs between the release of the falling arm and the closing of the feed gates. During these two successive periods there is a flow of grain from the dribble hopper into the bucket, and the material represented by this flow will be in excess of the amount required to make the beam equilibrate. It might be possible to compensate for this lag in the stoppage of the flow by setting the trigger to make contact with the hanger slightly in advance of the instant when the beam reaches the horizontal position. Such a step would, however, be objectionable, because it would aggravate the external restraint on the beam in the horizontal position. Further, the lead given to the trigger would have to be changed with each change in the nature of the material being weighed. Again, the dribble feed, however fine it is made, must still possess some momentum, and, as a consequence, will be equivalent to a weight in excess of its static weight. Finally, the beam approaches the horizontal position with perceptible velocity, and therefore tends to pass through the horizontal position earlier than is justified by the static weight of the grain in the bucket.

Some of these factors have the effect of making the weighment heavier than it should be, while others tend to make it too light. They cannot be relied upon to cancel out. There is a residual effect for which compensation must be provided. Generally speaking, the residual effect of these various factors is in the direction of making the weighment too heavy. It can, therefore, be compensated by making the bucket end of the beam heavier than the weight box end.

In most designs of automatic weighing machines, an adjustable weight is provided on the bucket arm of the beam. The correct position at which to set this weight is determined by trial and error, each trial necessarily involving the admission to the bucket of a batch of material, its weighing and its discharge. In the "Reform" machines, Henry Simon, Ltd., have provided a means of determining the correct position of the weight in one operation with complete certainty. The arrangement is shown in Fig. 6. It consists of a counterpoise A carried on a rod B, which is mounted at C on a knife edge projecting from the beam co-axially with the central knife edges of the beam. The other end of the rod is supported on a pin at D. A second pin is provided at E, and the knife edge end of the rod B is so shaped that the rod may be swung round the knife edge and allowed to rest either on the pin D or the pin E. In use, a weighment is made with the test quadrant *a*—Fig. 2 *ante*—swung up so that the batch is retained in the bucket after the feed gates have been closed. During this weighment the rod B, Fig. 6, is held clear of both pins, but afterwards it is lowered on to the pin E. The weight A is then moved along the rod until the beam equilibrates. The weight is secured in this position and the rod is turned about its knife edge until its end rests on the pin D. Subsequent weighments are made with the rod and weight in this position, and, it is claimed, are bound to be correct for the given material and rate of feed. In effect, the procedure results in the excess weight of a trial batch being weighed and then in the application to the beam of a counterweight that in succeeding weighments will deduct an amount equal to the excess found by the trial weighment.

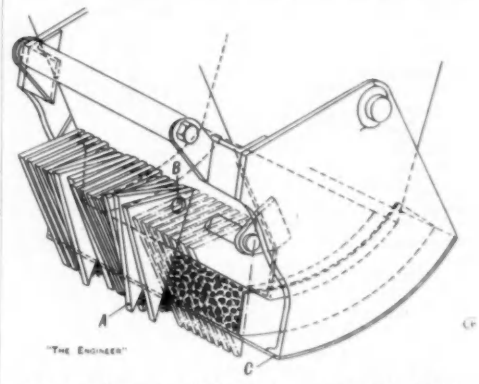

FIG. 7—FEEDING MECHANISM FOR COAL, ETC.

Feeding Mechanism for Coal, &c.

In the automatic weighing of coal, ore, &c., a common difficulty encountered is the lodging of pieces of material between the edge of the feed gate and the edge of the hopper when the gate is in the act of shutting off the feed. If the lodgment persists, the gate will be prevented from completing its movement, and particles less in size than the lodged piece may continue to pass into the bucket. A common means of overcoming this difficulty is to hinge the side of the hopper against which the gate, when closing, is apt to pinch the material. This plan permits the gate to complete its movement, but it does not prevent small-sized particles continuing to pass into the bucket.

The system adopted by Messrs. Simon for overcoming this difficulty is illustrated in Fig. 7. The hinged hopper wall of the ordinary system is in effect replaced by a hinged wall which is also flexible. The wall consists of a number of closely spaced triangular plates A drilled at one corner B to hinge on a horizontal cross rod fixed to the hopper body. The series of hypotenuses forms a continuation of the wall of the hopper, and the lower corners of the triangles project slightly below the lip of the feed gate. When the feed gate closes, its lip C lifts the plates slightly, and, when it opens, the plates follow the lip through a short distance until they come against a

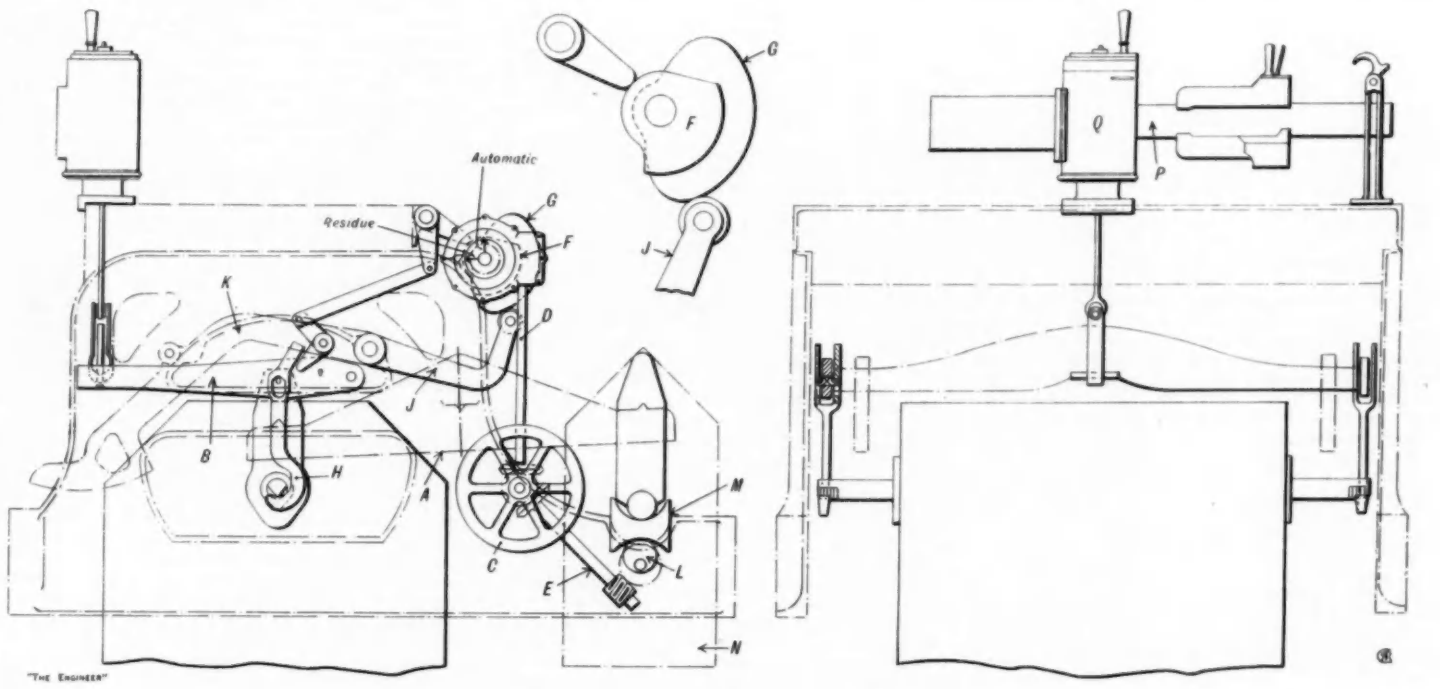

FIG. 8—RESIDUE WEIGHING MECHANISM

* No. I. appeared January 25th.

stop. Should a portion of the material being handled be caught by the lip of the feed gate as the gate is closing, those plates in contact with the jambed piece will swing farther than usual. The rest will remain in contact with the feed gate lip and will seal the hopper against the discharge of excess material. When the feed gate reopens, the jambed piece will drop into the bucket and the plates will regain their normal position.

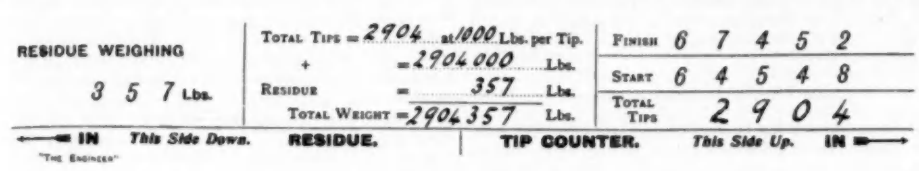
RESIDUE WEIGHING
3 5 7 Lbs.
TOTAL TIPS = 2904 at 1000 Lbs. per Tip.
+ = 2904000 Lbs.
RESIDUE = 357 Lbs.
TOTAL WEIGHT = 2904357 Lbs.
FINISH 6 7 4 5 2
START 6 4 5 4 8
TOTAL TIPS 2 9 0 4
IN This Side Down.
RESIDUE.
TIP COUNTER.
This Side Up. IN
"THE ENGINEER"

FIG. 9—SAMPLE WEIGHT TICKET

RESIDUE WEIGHING.

The last batch of a run of material will not, in general, provide a full weighment. The magnitude of this residue and the value of the material may be such as to render the determination of its weight essential. When it is required, the residue-weighing mechanism fitted by Messrs. Simon to their "Reform" automatic weighers takes the form illustrated in Fig. 8. The principle employed consists of transferring the weight of the bucket and its contents from the beam A to a beam B of the "second order," to which a steelyard fitted with a poise is attached. The whole operation of transferring the load from the one beam to the other is effected by a simple rotation of the hand wheel C.

From the hand wheel C power is transmitted through bevel gearing to two shafts D E. The shaft D through worm gearing drives a pair of cams F G. During the first portion of the movement of the hand wheel C, the cam F lowers the hook H—and a similar hook on the other side—by means of the linkage shown. These hooks are mounted on knife edges on the beam B and are normally held deflected by the linkage and the cam F. When they are lowered for residue weighing, they pass beneath the knife edge trunnions of the bucket. Towards the end of the movement of the hooks H the cam G acting on a roller at the end of an extension J of the falling arms K lifts these arms out of contact with the bucket hangers, and by so doing relieves the bucket of the weight of the falling arms and of the gate-closing levers. Meanwhile, the rotation of the shaft E has turned an eccentric L and has caused a slide M to rise beneath the hangers of the weight box N. Relieved of the weight box, the beam A dips at the bucket end and lowers the bucket on to the hooks H. The weight of the bucket hangers still remains as an unbalanced force on the beam A, and consequently the motion of that beam continues until the hangers fall clear of the bucket trunnions. In this condition the bucket is hanging freely on the beam B and weighing of the residue by means of the steelyard P can be proceeded with. A continued movement of the hand wheel restores the machine to its normal setting, and discharges the bucket.

Combined with the steelyard there may be a ticket-printing device Q, designed to record on a ticket the weight of the residue. A similar device can be fitted to print on the ticket a record of the number of complete weighments made from the beginning of the run up to the last complete batch before the residue is weighed. A sample ticket is illustrated in Fig. 9. On the right the number of complete batches passed through the machine is recorded. On the left the weight of the residue is shown. The total weight of grain passed through the machine is exhibited at the centre. In addition to a ticket printer, the machine may be fitted with a counter of the cyclometer type, for showing at a glance at any time the number of complete batches passed through the machine up to the instant of inspection. This counter is operated by rods and levers from the bucket door, and advances by one unit each time that door opens.

In Fig. 10 we illustrate a "Reform" automatic weigher fitted with the residue weighing and ticket printing devices just described. The form of compensating device shown on this machine is the same in principle as, but different in detail from, that illustrated in Fig. 6.

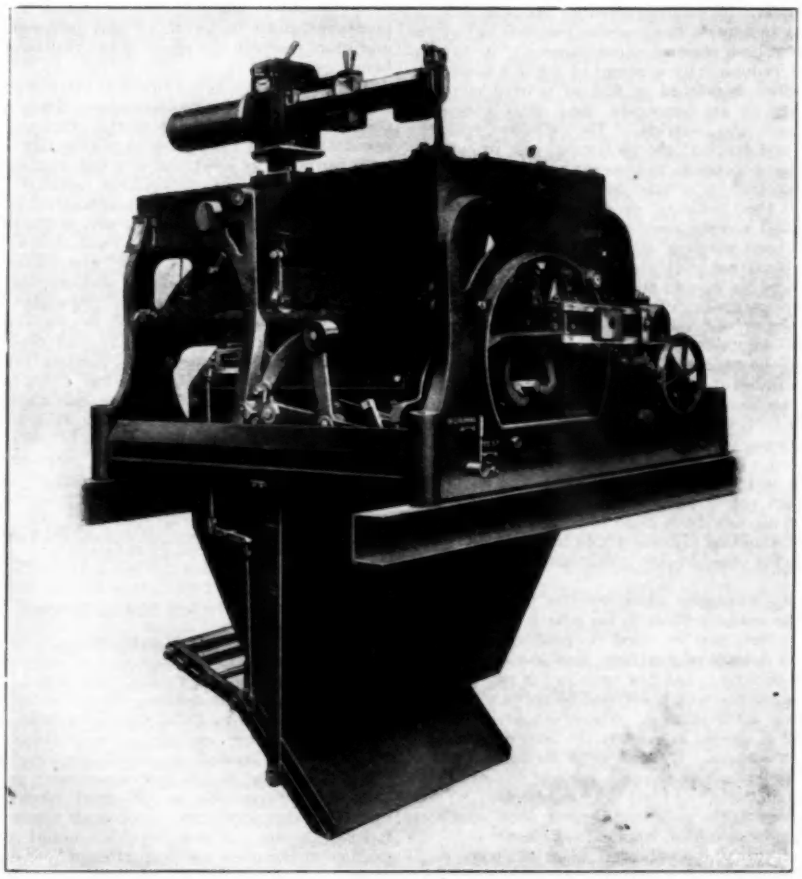

FIG. 10—"REFORM" AUTOMATIC WEIGHER WITH RESIDUE WEIGHING AND PRINTING DEVICES

HOPPER FEED CONTROL.

If the feed to the hopper is not uniform or is liable to be interrupted, it is desirable to ensure that the feed gates shall not open if there is insufficient material in the hopper to provide one complete weighment. In Fig. 11 the means provided for this purpose are illustrated. The mechanism consists of a deflecting valve or shutter A pivoted inside the hopper at B and counterbalanced at C, and connected by a linkage system ending in a stop D. In the position shown, this stop is engaging with a pin on the side of the main feed gate and is preventing that gate from opening. If, however, there is sufficient material in the hopper to ensure a complete weighment, the pressure of the material against the deflecting valve will move the stop D out of the path of the pin and allow the feed gate to open. When the time arrives to measure the residue remaining in the hopper, which residue, of necessity, is insufficient to operate the deflecting valve the stop is moved out of the path of the pin by means of the handle E.

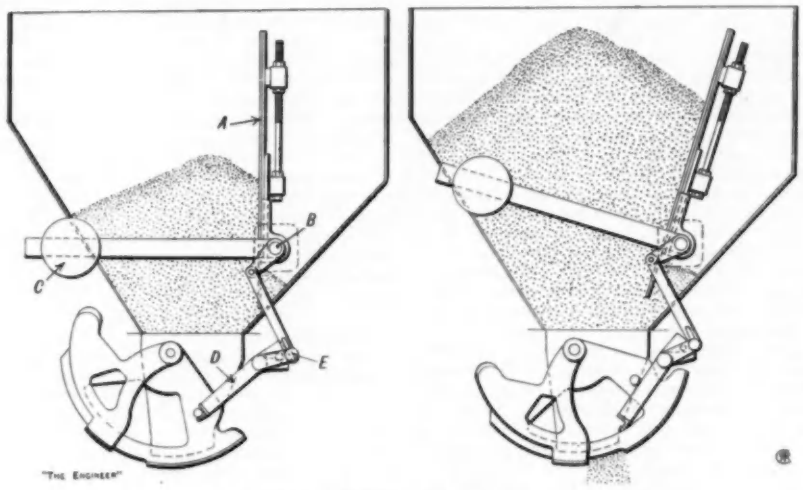

FIG. 11—HOPPER FEED CONTROL

DISCHARGE CONTROL.

When powders and light or dusty materials are being weighed and delivered directly into sacks, it is frequently found that the rush of material from the bucket into the sack displaces the air in the sack at such a rate as to carry light particles of the material with it. The "Reform" discharge control devised to prevent this action is illustrated in Fig. 12. The bucket door is fitted on each side with a sweep A, which, when the door opens, engages with an adjustable roller stop B. The extent to which the door opens is, therefore, limited in the early stages of the discharge. As the material, its flow reduced to a low rate, leaves the bucket, the beam begins to rise, but so long as the ends C of the sweeps remain in contact with the rollers the bucket door will not open farther. Just before the weight box strikes its stops the sweeps rise clear of the rollers and the bucket door is enabled to open to its full extent. The closing of the door takes place in the usual way before the bucket begins

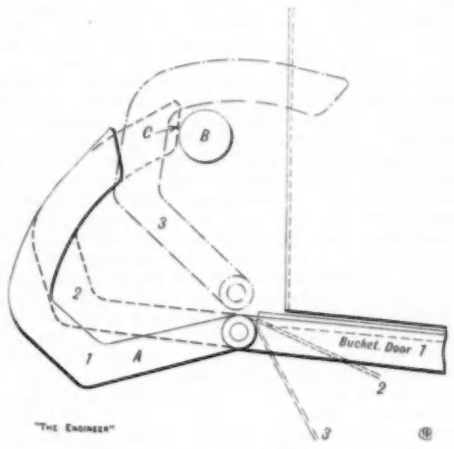

FIG. 12—DISCHARGE CONTROL

to descend again. This device can by the adjustment of the position of the rollers B be set to make the material enter the sack at any desired speed. It also has the merit that it prevents the weight box returning on to its stops with a high velocity.

(To be continued.)

Scientific and Industrial Research.

THE report for the year 1927–28 of the Department of Scientific and Industrial Research has reached us since the appearance of our last issue. Following our usual practice, we append excerpts from that portion of the report contributed by the Department's Advisory Council, a body of which the administrative chairman is Sir William S. McCormick and the secretary Mr. H. T. Tizard. The report is obtainable from his Majesty's Stationery Office, price 4s. net.

INTRODUCTORY REMARKS.

The year under review has been notable for a marked development of industrial research. Evidence of this reaches us in many ways: from personal contacts through industrial research associations, from the increasing interest taken in the work of the Department's research organisations, and from the enhanced demand for scientifically trained *personnel*. The rapid development of research in the chemical industry has even caused the Department some embarrassment through the resignation of many of the staff of the Fuel Research Station and Chemical Research Laboratory in order to take up research posts elsewhere. While the loss of experienced men is bound to delay, to some extent, the progress of investigations of general national importance, there is the compensating advantage that, at a time when the expansion of work of more immediate industrial interest is highly desirable, it is extremely helpful to industry to be able to turn to national organisations for the supply of men who appreciate at least some of the difficulties of getting practical results. The Industrial Research Associations, in spite of financial difficulties, are gradually securing the greater confidence of the industries they serve. As their schemes of work progress, practical results of considerable importance are beginning to emerge. Two developments are worthy of special mention.

The Wool Research Association has succeeded in introducing, this year, a new woollen ring spinning frame which is believed to be capable of producing two and a-half times as much yarn per spindle as the standard frame, and of giving a superior yarn. Machines based on the Association's design have successfully passed manufacturers' tests and will be brought into use by the industry shortly. The interest of this work lies not merely in the final result, but in the methods by which the result was obtained. It is the outcome of an exhaustive analysis by the latest scientific methods of the exact functions of every part of the existing "standard" machines; an analysis which showed clearly the directions in which simplicity could be effected without destroying practical efficiency. Similar work is being undertaken by other textile research associations, and might indeed be imitated with advantage elsewhere. There is a marked difference, from a scientific point of view, between many of the products and machines of the newer and the older industries. The dynamo, the turbine, the internal combustion engine, and the aeroplane, imperfect though they still may be, represent to-day the outcome of the practical genius of engineers who make use of the latest scientific knowledge and methods in their work. The same cannot be said of some of the equipment of older industries, which represent rather the scientific knowledge of previous generations combined with, but often unnecessarily complicated by, the ingenious improvements introduced by practical men who have not had to hand the means of ascertaining accurately the real extent and value of the changes. Even a British locomotive, admirable as it is in many ways from a practical standpoint, could, with hardly any doubt, be radically improved if scientific methods of testing and investigation were employed. It is surprising to learn from the inaugural address of the President of the Institution of Locomotive Engineers, in September, 1927, that locomotive engineers have "not at their disposal any facilities for trying out experimental scientific research," and that there is no existing organisation in this country which is available generally for the accurate testing of the performance and thermal efficiency of a locomotive. As a result of recent conferences held on this subject, we hope that this difficulty may be removed by the establishment of a national organisation for locomotive research.

The second development which deserves mention, though for somewhat different reasons, is the new lead alloy introduced by the Non-Ferrous Metals Research Association as a result of investigations undertaken in co-operation with the Research Department, Woolwich. This alloy is now being extensively used as a covering for electric cables by reason of its freedom from the defect of a peculiar type of cracking which, though somewhat rare in occurrence, causes from time to time serious trouble and financial loss to users. It appears capable of wide application in other directions, for it has been shown to have a strength, weight for weight, some 40 per cent. greater than the ordinary commercial lead which is used for lead pipe. This result may prove to be of considerable economic value, but the Association has hitherto failed, in spite of many efforts, to arouse any interest in it among manufacturers of lead pipe and sheet. A reluctance to try anything new is not a sign of a progressive industry.

CEMENT AND CONCRETE RESEARCH.

We have had under special review the investigations now being conducted at the Building Research Station into cements and concretes, bearing in mind the technical position of these industries and the problems with which they are faced.

It is to the credit of British manufacturers that they have led the world in producing Portland cement, although the processes used were almost entirely empirical. Urged later by the increase of propaganda in favour of foreign aluminous cements, they have been successful—again by empirical methods—in producing a rapid-hardening Portland cement of high character, and, in addition, an aluminous cement. The annual output of the industry is still increasing, and so far as production and distribution are concerned it may be said to be effectively organised. But much scientific work remains to be done, and the industry cannot afford to rely on empirical methods.

The technical difficulties which confront the user of cement and concrete are many and various. We will indicate here briefly some of the problems which have engaged the attention of the Building Research Station during the past few years. Portland cements are peculiarly liable to chemical attack, and are not highly resistant to fire. These defects can be traced to the presence of free lime after hydration. Certain materials can be added to unite with this lime and thus render the concrete more fire resistant, and less liable to chemical action. Such materials are grouped generally under the name pozzolanas, and include volcanic rocks and other natural materials, burnt clay, spent oil shales, blast-furnace slags, and furnace clinkers. Unfortunately, there is at present no marketable source of suitable British material, although there seems every reason to believe that scientific investigation will lead to appropriate sources being exploited. The financial and technical co-operation of the Association of Portland Cement Manufacturers, the Dunstable Cement Company, the Anglo-Persian Oil Company and Imperial Chemical Industries has now been secured in the study of the problem of pozzolanic action, with the ultimate object of providing a suitable British source of pozzolanas.

The widespread use of clinker and breeze aggregates in concrete for housing schemes has been successful in many instances, but has also resulted in failures which have had serious consequences. A typical example is provided by a group of eight houses, the walls of which consisted of 6in. of poured concrete with clinker as an aggregate, and with a cement rendering on the outside. The clinker concrete expanded and cracked the rendering, and in spite of repairs, the expansion continued until the houses became structurally unsafe for habitation. At the request of the Ministry of Health, the Building Research staff investigated the cause of these failures, which had been assumed to be due to the formation of sulphur compound in the cement. The actual cause was shown to be due to the presence of particles of unburnt or partially oxidised coals in the clinker, which by the subsequent action of water and oxygen caused local expansions resulting in stresses sufficient to break up the concrete. It was shown, too, that not all types of unburnt coal were dangerous; the dangerous coals can be classified by laboratory experiments, and are, in fact, very similar to the types of coal liable to spontaneous combustion. Practical tests have been evolved which can be applied with the simplest equipment and the minimum of skill, and although these are not yet so satisfactory as could be desired, enough has already been done to indicate the correct methods of avoiding failures which have already been responsible for considerable public and private financial loss.

These two examples illustrate the problems that confront the manufacturer in his search for available materials which can be used to produce a cement without the defects of Portland, and less costly than aluminous cement; and the user in his attempts to make an aggregate which will not be subject to rapid deterioration after setting. There is another group of problems of special interest to the designers of large concrete structures. By the time modern concrete came into practical use the principles of design of iron and steel structures had been fully established. These principles rest on the main assumption that steel is an isotropic elastic material, which is sufficiently accurate within the limits of load allowed. But when the engineer applies—as he does apply—the same principles to the design of concrete structures he enters a region of great uncertainty. Concrete is a material the properties of which vary with very slight differences in manufacture. The standard methods of test used to determine the strength of steel give very erratic results when applied to concrete; and the value of the modulus of elasticity is anything but constant. In fact, there are two main differences between concrete and steel which are in themselves sufficient to account for the many anomalies observed by engineers; the first is the normal expansion and contraction of the material as the moisture in the surrounding atmosphere varies, and the second is the gradual flow of concrete under load. The movements so caused are often many times greater than the "elastic" movements on the calculation of which the design of structures is based, and many engineers hold that the recognition of the importance of these fundamental differences between concrete and steel renders obsolete the present methods of design. This must not be taken as an alarmist statement; indeed, it is obvious from the last twenty years' experience that the dangers associated with incomplete knowledge have been avoided in practice by that form of insurance against error which is known by engineers as the "factor of safety." But that is no reason why ignorance should continue to exist, when steps can be taken to dispel it. Investigations at the Building Research Station on the measurement of adhesion stresses, and of stresses introduced in the steel of reinforced concrete by the shrinkage of cement have already been productive of data of much importance. The flow of concrete under load is being measured under conditions which allow of the accurate control of temperature and humidity. The further these investigations go the more they emphasise the need for a thorough study of the basic physical and chemical properties of cement. There is no doubt that cement materials are similar to those classified by the physical chemist as "gels," and until the properties of such gels are better understood it will not be possible to build up accurate generalisations for practical application.

RESEARCHES ON ALLOYS FOR USE AT HIGH TEMPERATURES.

We have reviewed the progress of these researches which are being carried out at the National Physical Laboratory under the general supervision of a Committee of the Department. During recent years a number of alloys which show considerable strength at high temperatures have been introduced and are now used in many branches of engineering. Of existing alloys, the improved steels have been mainly due to industrial research in this country, whereas the non-ferrous alloys owe their introduction largely to research abroad. The exact knowledge of the properties of these alloys is of great importance to engineers, and considerable attention has therefore been given at the National Physical Laboratory to the design of apparatus to give accurate data of the "creep" of metals up to temperatures of the order of 1000 deg. Cent. A number of alloys at present on the market has been tested and the results published.

A detailed study has also been begun of the mode of deformation and fracture of metals at high temperatures, both under rapid and prolonged loading, and more recently the effect of intermittent loading is being examined.

The use of these new alloys has facilitated advances in engineering in many directions. They have made possible the improvement of the efficiency of power generating plant. They are used to a large extent for such purposes as electrical heating, and are essential for the modern heavy chemical industry. There is no reason to believe that the industrial successes so far obtained, striking as they are, indicate anything more than the opening up of a fresh field of industrial development. There is little knowledge of those ultimate properties of alloys and metals on which strength at high temperatures depends, and much work has already been carried out at the National Physical Laboratory in the hopes of throwing light on this fundamental question. A general investigation has been made of nickel chromium alloys for the purpose of correlating the structure and constitution of these alloys with their behaviour at high temperatures, and although the object of this work is primarily to obtain the kind of scientific information which would be useful in guiding and foreshadowing industrial advances, it has already had a practical outcome in demonstrating the superiority of alloys of nickel with 30 and 40 per cent. of chromium to the 20 per cent. chromium alloys which are now in commercial use.

RESEARCH ON MINOR METALS.

We have also reviewed the progress of the researches on minor metals undertaken at the National Physical Laboratory under the general direction of the Minor Metals Research Committee. The object of this work, which was begun in 1922, was to provide more complete data on those metals, such as cadmium, which already find a limited use in industry, and to explore the properties of metals hitherto unused, in the hopes that the information so obtained might stimulate industrial developments of minerals occurring in the British Empire. A considerable amount of work has been carried out on the properties of cadmium and its alloys. This metals is available as a commercial product in a state of comparatively high purity, and is already used to some extent notably in the form of an alloy of 1 per cent. of cadmium with copper, which is superior to copper itself for conductors, such as trolley wires, where tensile strength is important. A detailed study of the constitution, structure and physical properties of the alloys of copper and cadmium has been carried out and the results published. The effect of cadmium in alloys of copper and zinc has also been investigated, with the result that it has been definitely shown that the presence of small

quantities of cadmium in brass is not deleterious, as was formerly believed. This is a result of considerable economic importance. The alloys of cadmium and zinc have been thoroughly studied, and particular regard paid to the possible use of certain of them as solders. Such solders have a greater strength than those of the lead-tin series, and they have a higher melting point, which is, however, sufficiently low to allow high-duty steels to be soldered without detriment to their quality.

The Committee has also paid much attention to the possible uses of beryllium. At the time when the work at the National Physical Laboratory was begun, beryllium could not be obtained except in the form of an impure powder, and it was found necessary to develop methods of production at the National Physical Laboratory. These methods have been successful in providing beryllium metal in a high state of purity, and it is believed that the experience gained will be of considerable value if beryllium is ever manufactured on a large scale in this country. It is extremely difficult, however, to produce the metal free from traces of oxide, and although chemical analysis indicates that the total amount of impurity present is small, there is ample evidence that it is sufficient to affect quite definitely the properties of the metal. For instance, the beryllium obtained at the Laboratory is brittle, and so far as is known no ductile specimens of beryllium have yet been prepared. There is no reason to believe that this is an essential property of beryllium; on the contrary, X-ray analysis of its crystal structure indicates that it is likely to be ductile in the pure condition. As is well known, recent work has shown that metals such as zirconium and titanium, which were formerly believed to be brittle, are ductile when obtained in a state of sufficient purity.

Beryllium is a much lighter metal than aluminium; it has considerable strength, a high melting temperature, a low coefficient of thermal expansion, and is not easily corroded when exposed to ordinary air. If it were available in sufficient quantities it would find a large number of practical uses. The cost of the raw material beryl is at the moment very much higher than the cost of the ores of the other lighter metals, magnesium and aluminium, but it is quite possible that it exists in larger quantities and in wider distribution than is at present thought.

The work on alloys of beryllium with aluminium has given somewhat disappointing results. It has been shown that the mechanical properties of these alloys are unlikely to be valuable. There is no evidence that an alloy of beryllium with aluminium will be superior to other aluminium alloys, unless experience shows that their lower coefficient of expansion is of importance for special applications. Alloys of beryllium with iron have, on the other hand, given very promising results, and we consider that the investigations should be continued.

Research on Stresses in Railway Bridges.

The Bridge Stress Committee has presented its report, which will shortly be published.*

It will be recalled that this Committee was set up on our advice, in 1923, after receiving representations from the Ministry of Transport and other interested bodies, that the whole question of stresses in railway bridges needed further investigation. The practical work in the field was finished in March, 1927, but the issue of a report has been delayed to let the Committee give the results full consideration, and especially to allow time for the completion of general theoretical investigations carried out by Professor C. E. Inglis for the Committee at Cambridge University. The delay has proved to be thoroughly justified. Professor Inglis' investigations, which were founded on the experimental work of the Committee, have made it possible to correlate the field observations, and, by applying the data of the tests, to develop a rational theory which can be used with considerable confidence to predict the stresses likely to occur in bridges of various types owing to the effect of moving loads.

Prior to the formation of the Committee there had been much work on the same subject in the United States, India, and at home. Unfortunately, this work led to no final conclusion, and bridge designers were left almost in the dark as to the proper allowances to be made for strengthening bridges sufficiently to guard against the so-called "impact effects" which are liable to take place when a train moves across at high speed. It was formerly considered that the actual movement of a load across a bridge was sufficient in itself to add considerably to the easily calculated stresses which are imposed by the same load when stationary. The Committee has shown that this is erroneous, and that, in fact, if the reciprocating parts of a locomotive were perfectly balanced, a train running smoothly on a track which presents no irregularities, would not impose substantially greater stresses than the same train at rest. In practice, however, certain irregularities have to be reckoned on as contributing to produce impact effects, and appropriate allowances are accordingly recommended by the Committee.

At the outset of the inquiry the Committee realised the importance of examining in detail the marked effect of what is called "hammer-blow," due to unbalanced vertical forces in the running of a locomotive. In exceptional circumstances, these unbalanced forces may be so great as to result in the driving wheels of a locomotive being actually lifted off the rail and coming down subsequently with increased force. Even if the wheels are not so lifted, there is an alternating pressure on the rails which may throw a bridge into a state of severe oscillation when the frequency of the alternations happens to coincide with the natural frequency of vibration of the bridge. The Committee points out that owing to a combination of causes the frequencies attained by locomotives in ordinary running agree closely with the natural periods of oscillation of railway bridges in very many cases. The partial resonance which may occur is not, therefore, an exceptional, but quite an ordinary phenomenon, though, in practice, its possible harmful effects are checked by such factors as the damping effect of the locomotive springs. In its report the Committee discusses in detail all aspects of the problem, develops practical formulas and numerical tables which can be applied by bridge designers, and indicates how a marked increase in the safety of bridges can be effected by modifications in the design of locomotives. It is satisfactory to note that the Committee's work has already borne fruit; certain classes of locomotives which were shown to exert hammer-blows of exceptional violence have been modified or withdrawn from service, and modern locomotives are now being designed so as to reduce the unbalanced vertical forces as much as possible.

* Issued to-day, February 1st, 1929.

Geophysical Methods of Survey.

The staff of the Geological Survey has continued its investigations of the use of the Eötvös torsion balance in determining the structure of underground deposits. In last year's report the successful accomplishment of a gravitational survey of the Swynnerton Dyke was mentioned, and late in 1927 it was decided to attempt the solution of a somewhat more difficult problem. In many parts of Britain there are old river channels carved out of the solid rock in pre-glacial and glacial times, but now completely filled by deposits of gravel, sand and clay, so that the country presents a level surface and no indication of the deeper structure is provided. Such channels may be of great importance in dealing with schemes of water supply, reservoirs, tunnels, mining, harbour and dock foundations, and it was thought probable that a survey by means of the Eötvös balance might disclose the underground rock surface contours and give accurate information regarding the shape and depth of buried channels. An area which seemed to provide the necessary conditions for a practical trial was selected about 6 miles north-west of Glasgow at Drumchapel, where there is a deep pre-glacial channel of the old river Kelvin now completely filled up and levelled over. Some information regarding the conditions was provided by a number of borings carried out many years ago in search of coal and ironstone. Field work was begun by the geophysical party in November, and with an interruption at Christmas was carried on till the beginning of March. Observations were obtained at sixty-eight stations, and a very minute survey of the surface configuration was also carried out. The observations are at present being discussed and reduced, and the results are being plotted on large-scale maps, and are not yet ready for publication. It is sufficiently established, however, at the present time, that a very large amount of information has been obtained regarding the configuration of this channel, which confirms and amplifies the somewhat scanty records previously in our possession.

Survey of the Coalfields.

The geological survey and the physical and chemical survey of the British coalfields have both made rapid progress during the last year. The progress has been greatly facilitated by the provisions of the Mining Industry Act of 1926, by which the Department was authorised to receive official notification of all deep borings in search of minerals, and given the right of access to underground workings, and the right to obtain samples of seams opened up or worked and to examine mining plans. We are glad to report that the arrangements provided in the Act have worked admirably, and that the officials in the mining industry have shown every willingness to afford the fullest information and facilities.

Research Associations.

During the year the nineteen Research Associations receiving grant aid from the Department submitted a memorial praying for the continuance of financial assistance for a period of ten years, on the basis of annual grants equivalent to the annual subscriptions of members of the Associations. In effect, the Associations desired a reversion to the policy adopted when they were first set up under the ægis of the Department.

We were unable to recommend the acceptance of the proposals made in this memorial. When the Associations were first formed, co-operative research in industry was an experiment, the result of which no one could accurately foresee. In the circumstances we considered that it was justifiable for the State to bear half the risk of the experiment over a period of five years. When this period came to an end we agreed that a continuance of State aid on a smaller scale was desirable in view of the special difficulties of British industry, and of the fact that five years proved too short a time for most of the Associations to establish their reputation by the results of their work. But now that nearly ten years have passed since many of the Associations were formed, we see no grounds on which we could justify a recommendation that half their expenditure should continue to be met from State funds for a further period of ten or even five years. We consider that if State aid is to be continued after the expiration of the present contracts it must only be after a careful consideration of each case, and that a policy of giving grants, on the scale desired by the memorialists, to every Association without discrimination would be a policy of weakness which would leave the Research Associations at the end of the period in a less satisfactory position than they are at present. It must be remembered that the object of Research Associations is to serve the industries to which they are attached. The main object of the State's assistance in the first place was to demonstrate that co-operative research was of service to industry. The conditions on which grants were given were made as simple as possible; the Associations are self-governing; they settle their own programme of research in relation to their own needs; and they are free to do what they will with the results, subject only to conditions designed to safeguard national interests. All that the Department demands is full information on programmes, results and expenditure in order that we shall be in a position to certify that the funds subscribed by the State are being properly used for the purposes for which they were given.

The main purpose has, in our opinion, already been achieved. Co-operative research has proved its value, it has come to stay, and we agree with the views expressed in the memorial on the importance of consolidating now the financial position of the Associations.

Some of the Associations have already given much thought to the practicability of substituting for voluntary contributions some equitable form of levy on the industries they serve. But we cannot hope for the early fruition of such schemes, and have had to consider seriously whether further State aid can be justified during the intervening period. We think it can be justified and propose that when the existing contracts come to an end each Association should be considered on its merits, and a subscription income fixed which it would be necessary for the Association to obtain from other sources before it was eligible for any grant from the Department. Funds obtained from approved sources in excess of this minimum subscription income should, in our view, be augmented by a grant equal in amount from the Department up to a limit depending on the circumstances of the Association. Thus the greater the effort on the part of any industry to maintain its ResearchAssociation adequately, the greater would be the direct encouragement of the State. But we do not propose that the State's contribution should, save in one case referred to below, exceed one-third of the total income unless circumstances arise of which we have no knowledge or anticipation at present.

There is one Research Association which, we think, should be treated differently. As we have said in previous reports, the British scientific instrument industry occupies a peculiar position. Its direct economic importance is small, but its indirect value is out of all proportion to its size. To maintain it in an efficient state requires a considerable expenditure on scientific research and experiment. We think that for many years it will be necessary and advisable for the Department to continue to allocate substantial funds for investigations of direct interest to the scientific instrument industry if the efforts of the industry itself are to bear full fruit. We consider that the British Scientific Instrument Research Association fulfils so important a function in bringing different sections of the industry together to co-operate in investigations of common interest, and forms so useful a link between scientific discoveries and their practical applications to the manufacture of instruments, that it has a valid claim for exceptional treatment by the Department. We recommend, therefore, that, in view of the inability of the industry to provide adequately for the maintenance of the Association, which we are satisfied is the present position, the Department should continue for an undefined period to supplement the annual contributions of industry by a sum sufficient, but not more than sufficient, to maintain the Association approximately on its present scale. Since this means that the Department will bear the major part of the expenditure, a stronger measure of control will have to be exercised over the operations of the Association, the disposal of results, and the conditions of service of the staff.

The Swedish newspapers report that a new method for the manufacture of fertilisers has been invented by M. Sven Nordengren, manager of the Konstgoedningsfabriken at Landskrona, and that a company with an initial capital of Kr. 270,000 is being founded to exploit the invention. The raw materials for Swedish 20 per cent. superphosphate products, for instance, have hitherto been imported from overseas countries, but with the new method it is stated that low per cent. raw materials can be used for the production of high per cent. superphosphate, so that the cheaper North African raw materials can thus be used. Trial production has been going on for six months at the Konstgoedningsfabriken and the fertilisers produced are said to be quite as good as those manufactured by the ordinary methods.

The Khartoum-Omdurman Bridge.

THE new bridge which has recently been completed across the White Nile, connecting Khartoum and Omdurman, was formally opened by Sir John Maffey, the Governor-General of the Sudan, on January 16th, 1928.

This bridge, the position of which is shown in Fig. 1, and which is illustrated at the top of page 132, constitutes the most important part of the work undertaken by the Sudan Light and Power Company under the concession which was granted to it by the Sudan Government in January, 1925. The new works, in addition to the bridge, comprise a complete new electric tramway system as well as the extension of the lighting and water services both in Khartoum and Omdurman. The bridge and electric tramways now replace the steam ferry and the old Decauville steam tramways which had been in use since shortly after the British occupation. As Dorman, Long and Co., Ltd., were represented in the group which forms the Sudan Light and Power Company, the design and construction of the bridge was entrusted to them.

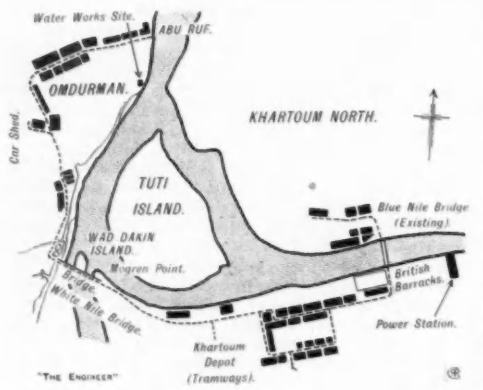

FIG. 1—SKETCH MAP SHOWING POSITION OF BRIDGE

Accommodation is provided on the roadway of the bridge and approaches for a single line, 3ft. 6in. gauge, electric tramway, the centre of which is placed at 7ft. 3½in. clear of the south main girder, and a roadway of 28ft. clear between the main girders—see Fig. 3. Provision is also made for a future addition of two cantilever footpaths, each giving 11ft. clear between parapets. The loads provided for are:—An electric tramway car weighing 16 tons with a wheel base of 7ft. 6in. and two trailers of 6 tons on a similar wheel base on the tramway zone, and on the roadway 150 lb. per square foot road surface with axle loads of a 12-ton steam roller. The levels are determined from datum fixed at 370 m. above mean sea level, which is 10 m. above absolute zero adopted at Khartoum. This datum of 370 m. is approximately lowest river level of the site of the bridge. The levels of the foundations of the piers were fixed by the level of the underlying rock, and range from a maximum depth of 9 m. to a minimum depth of 3·5 m.

The caissons are terminated at level 370 m. or at lowest water level, while the pier shafts are carried to level 378·70 m., which makes the underside of the bridge 379·50 m. and the roadway level 380·45 m. respectively. Thus the superstructure gives the minimum clearance of 2·80 m. above highest recorded river level.

During the progress of the work a slight departure from the original design was found necessary and the general dimensions of the bridge as completed will be seen on referring to Fig. 2. The bridge contract extended over a length of 3466ft., the bridge proper consisting of seven spans of 244ft. and one swing span of 304ft., making the total length of steel superstructure of 2012ft. Two views of the swing span are given on page 132. The approaches to the bridge were 850ft. long on the east or Khartoum side and 634ft. long on the west or Omdurman side.

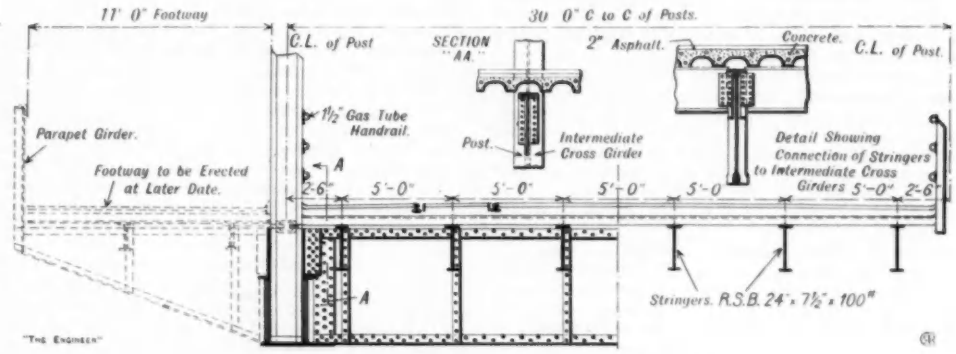

FIG. 3—CROSS SECTION OF ROADWAY OF BRIDGE

The conditions governing the selection of the site and the alignment of the bridge were suitable rock foundation, the point of approach on the west bank, and the width of the river. The site is near the junction of the White and Blue Niles and takes off from the east bank at what is known as Moghren Point, crosses Wad Dakin Island, and reaches the Omdurman bank just south of the limit of the permanent buildings on that shore. The clear waterway provided at high river during September and October is approximately 1600ft., which is sufficient to take the maximum discharge, although the river during this period is considerably wider owing to the inundation of both the foreshores. During the low river season, January to April, the flow is confined to two channels east and west of Wad Dakin Island. The maximum current velocity occurs in February in the western channel and is about 2 m. per second. The White Nile is navigable for about 1100 miles south of this point and the western channel is used for the passage of steamers, and the swing span was consequently placed in the centre of this channel. Throughout the length of the bridge it was found by borings that the Nubian sandstone extended practically level and all the piers were carried down and founded on the solid rock.

The eastern or Khartoum approach has a gradient of 1 in 60 until it reaches the bridge, while the western or Omdurman approach is carried level throughout. The section adopted gives 10 m. between fences with a berm of 1 m. beyond, while at both ends of the bridge the embankment is widened sufficiently to embrace the cantilevers when added. The road surface is of tarmacadam on 9in. of soleing and is formed to camber in the usual manner. The tramway is accommodated on the south side as on the bridge.

As considerable wave action is produced by storms during the flood season the side slopes, which are 1½ to 1, are pitched to a depth of 1ft. 6in. with stone built in cement mortar. The pitching is carried about 2 m. above highest recorded flood level. At the extreme ends of the bridge the roadway is retained by a reinforced concrete ballast wall built on the cylinder foundation of the abutments, these cylinders being entirely embedded in the bank.

As already mentioned, the foundations vary in depth, and the lower or caisson sections, which cease at low-water level, range in length from 29ft. to 12ft. The abutments and piers of the fixed spans are nine pairs in number and consist of a caisson section of 16ft. diameter and a pier shaft section of 10ft. diameter. The two cylinders are placed at 30ft. centres and are braced above low-water level. At the point where the shaft section connects with the caisson it is telescoped for 3ft. and further reinforced with eight 50 lb. rails of a length of 15ft. The steel work of these piers is of the usual design, the caisson being provided with a cutting edge and working chamber from the roof of which spring the air lock tubes. The pier shaft is a simple cylinder of $\frac{3}{16}$ in. plate stiffened and braced internally. On completion, these cylinders were filled solid with concrete. The mixture mainly used was 7 : 3½ : 1, but at the two points of reinforcement, viz., the junction of caisson and shaft, and the tops of the shafts on which the main girder bearings rest, a mixture of 4 : 2 : 1 was employed. The aggregate was of granite broken to pass through a 2in. ring and provided from the Gebel Royan Quarries. The sand was obtained from local sources. The swing pier had to be dimensioned sufficiently large to accommodate the roller path and mechanism and was 33ft. diameter on the caisson portion and 30ft. diameter on

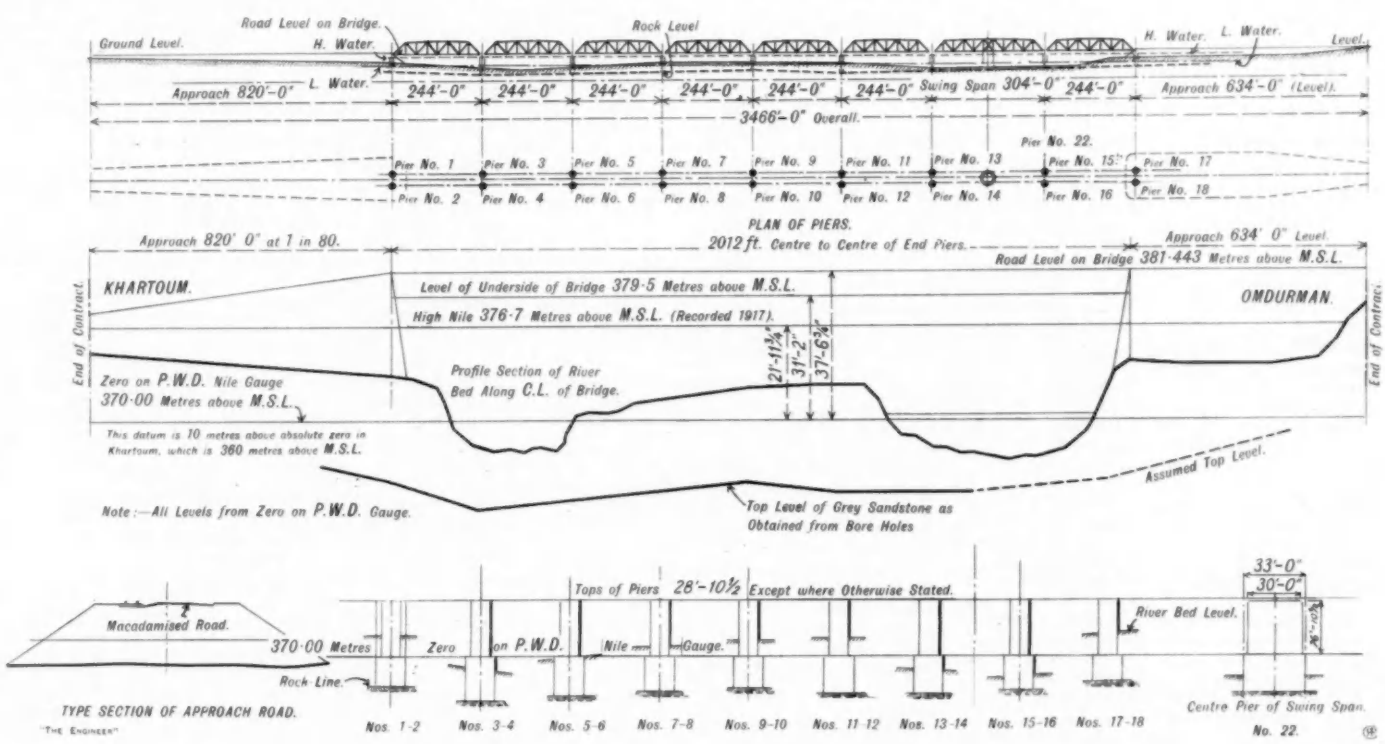

FIG. 2—PROFILE AND PLAN OF BRIDGE SHOWING POSITIONS OF PIERS

the shaft portion. These two parts were reinforced and the steel construction is of a similar nature to that of the small cylinders.

The fixed spans—Fig. 4—are 240ft. long centre to centre of bearings and the main girders are placed at 30ft. centres apart. The main trusses are of the simple Warren type in eight panels of 30ft., and having a depth of 36ft. at the centre and 30ft. at the ends. The cross girders are secured to the posts in the usual manner and between them the flooring of inverted steel troughing is carried on a series of 24in. by 7½in. R.S.J.'s, an expansion joint—Fig. 5—of the usual type being provided on the roadway between the ends of the spans. The roadway surface is of Lithocrete, 2in. in thickness, carried on a bed of concrete, the minimum depth of which is 5½in. over the top of the steel troughing. The tramway track of 3ft. 6in. gauge is of flat-bottomed rails of 75 lb. per yard, with a 4in. by 1in. steel bar bolted inside to form a guard rail, and the gauge is retained by tie rods at 3ft. centres, with adjustable nuts. The lower flanges of the rails and the tie rods are embedded in the concrete and the Lithocrete surface is laid flush with the top of the rails.

It will be seen on reference to Fig. 6 that the outline of the swing span is made to conform with that of the fixed spans, but its length is 300ft. between end bearings. This length was determined by the clearance required to give passage for the river steamers, the fairway being slightly on the skew at this point. In order to facilitate the passage of sailing craft and also to protect the swing span when in the open position, a floating dolphin of steel construction, which reaches 235ft. upstream and 175ft. downstream of the centre line of the bridge, has been provided. This dolphin is guided on the swing pier by vertical guides and moorings at the extreme ends. It is of similar design to the dolphins generally adopted on the Lower Nile bridges.

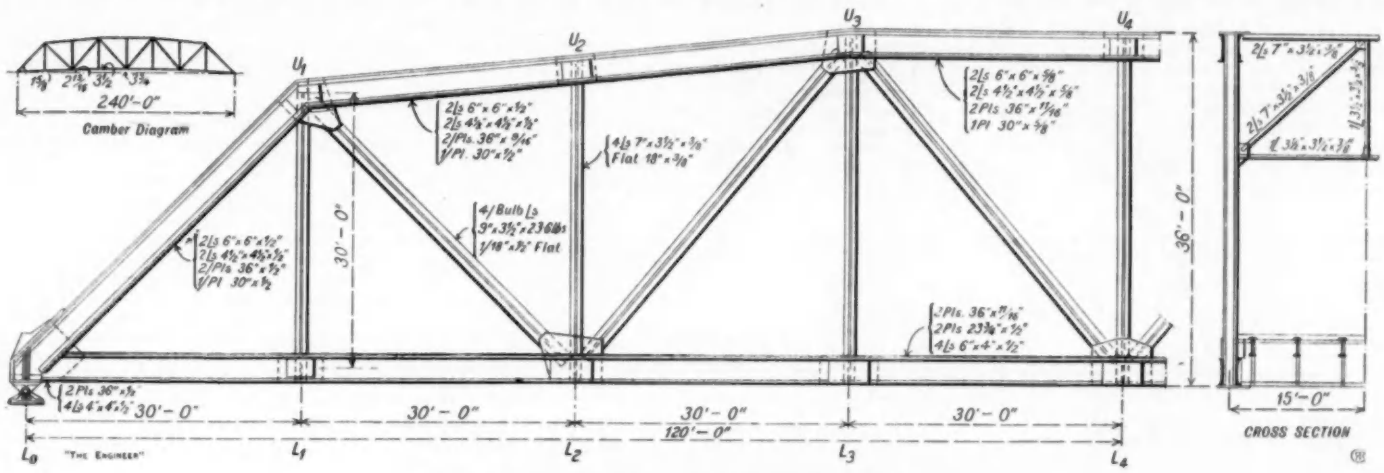

FIG. 4—HALF ELEVATION AND SECTION OF FIXED SPAN

The swing span when rotating is carried at its centre on a roller path of 25ft. 4½in. diameter, 11½in. on the face, having a frame of live rollers, while in its closed position, and when taking the load it is supported on its extreme ends by bearings on the adjacent piers of the fixed spans. These end bearings are of the usual screw wedge type, and when screwed home reduce the deflection in the ends of the main trusses by 1½in., and in this way adjust the stresses in the main trusses to take the working loads which are experienced when the bridge is in the closed position.

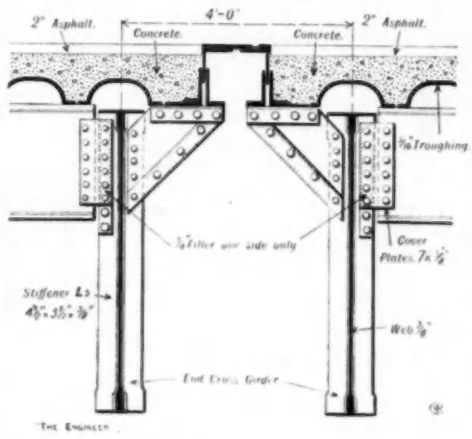

FIG. 5—EXPANSION JOINT BETWEEN FIXED SPANS

The swing span is operated electrically, and there is an auxiliary hand gear, which is capable of being thrown in when required by a simple dog clutch. The turning motor is of 20 horse-power, which runs at 500 revolutions per minute, and is geared on to the rack of the roller path in the following manner :—

On its spindle is a pinion A, Fig. 7, having twenty teeth which meshes with a toothed wheel B, which is arranged at the centre of a cross shaft N, and which has 100 teeth. The ratio of speed reduction is, therefore, as 5 to 1. At each end of the shaft N there is a pinion C C^1, with 28 teeth. These wheels mesh with toothed wheels D D^1 on countershafts O O^1. The wheels D D^1 have 76 teeth. The ratio of speed reduction between the shaft N and the shafts O O^1 is, therefore, approximately as 2·71 to 1. The far end of the countershafts O O^1 carry bevel pinions G G^1 with 23 teeth, which gear with bevel wheels H H^1 with 50 teeth, which, in their turn, are mounted at the heads of down shafts P P^1, the ratio of reduction being nearly 2·18 to 1. At the lower ends of each of the shafts P P^1 are mounted pinions J J^1, which have 20 teeth, and which mesh with toothed wheels K K^1 having 72 teeth, at the top of vertical jack shafts, the lower ends of which each carries pinion L L^1 with 15 teeth, that meshes with the circular rack attached to the underside of the body of the span. The result of the various reductions is that with the motor running at 500 revolutions per minute, the shaft Q Q^1, and hence also the pinions L L^1, make about 4¾ revolutions per minute. It will be understood that the pinions L and L^1 mesh with the circular rack at diametrically opposed points.

Should the motor break down or should the current fail, the span can be operated by hand in the following manner :—The shafts O O^1 carry dog clutches, by means of which they can be disconnected from the toothed wheels D D^1, and hence from the motor. Mounted on the shafts O O^1 are bevel wheels E E^1, which mesh with bevel pinions F and F^1 respectively. These pinions are keyed to the bottoms of vertical spindles F^2 and F^3, the tops of which are made square, so that they may be operated by means of keys from the deck of the span. Both spindles and clutch handles are accessible through manholes.

The time required to swing the span by power through a right angle is about 3 minutes.

The wedge motors are placed on the ends of the

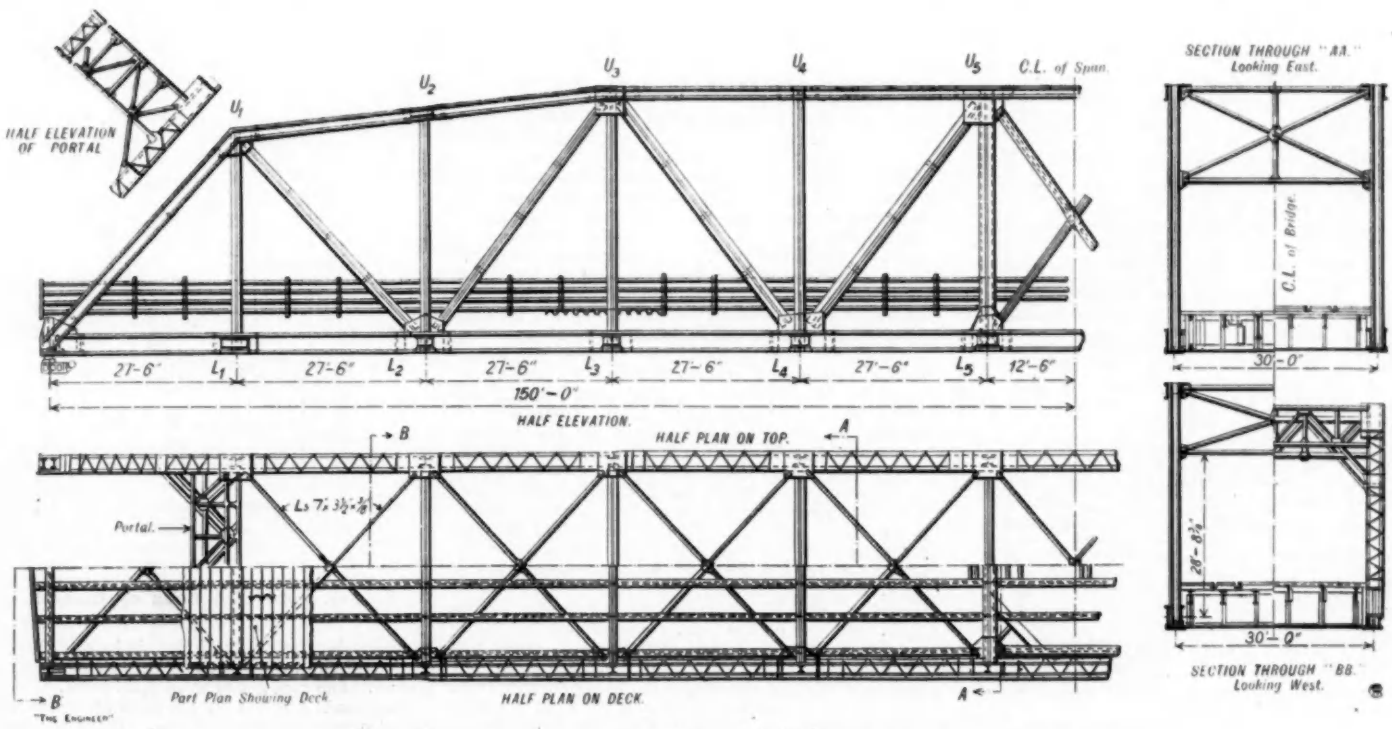

FIG. 6—HALF ELEVATION AND DECK PLAN, AND SECTIONS OF SWING SPAN

fixed spans and are of 6 horse-power, with a speed of 1000 revolutions per minute. All the motors are operated by simple drum controllers, one being placed on a platform in the centre of the swing span, while the two operating the wedging motors are arranged in suitable refuges on the ends of the adjacent fixed spans. No buffers are provided, and the limit switches are so placed that should the operator over-run in either direction he can reverse, when the limit switches will reinstate themselves automatically. The floor of this span is of a construction similar to those of the fixed spans, and the whole span when in the swinging condition weighs approximately 650 tons.

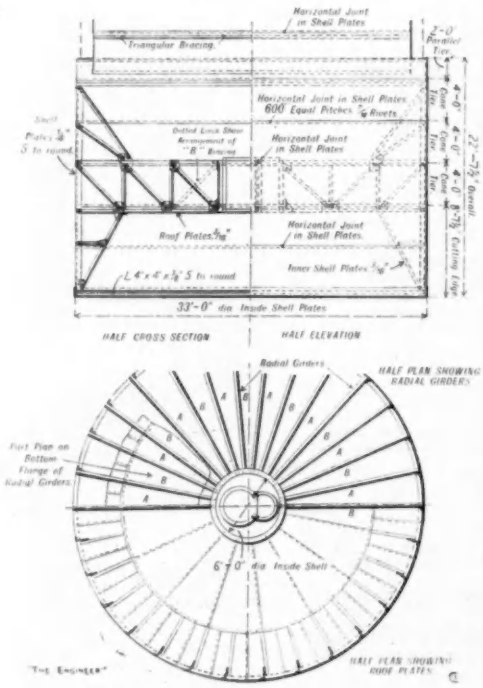
Horizontal Joint in Shell Plates
"Triangular Bracing."
2'-0" Parallel Top
Horizontal Joint in Shell Plates 600 Equal Pitches 7/8" Rivets
4'-0"
4'-0"
4'-0"
8'-7½"
22'-7½" Overall
Cutting Edge
Shell Plates 3/8" 5 to round
Dotted Lock Shear Arrangement of "B" Brackets
Horizontal Joint in Shell Plates
Roof Plates 5/16"
Horizontal Joint in Shell Plates
L 4" x 4" x 7/16" 5 to round
Inner Shell Plates 5/16"
33'-0" dia. Inside Shell Plates
HALF CROSS SECTION
HALF ELEVATION
Radial Girders
HALF PLAN SHOWING RADIAL GIRDERS
Part Plan on Bottom Flange of Radial Girders
6'-0" dia. Inside Shell
HALF PLAN SHOWING SIDE PLATES
"THE ENGINEER"

FIG. 8—CAISSON OF SWING SPAN

The filling for the approach embankments was taken from borrow pits on the upstream side permanent banks, at a sufficient distance to prevent any displacement during the flood season. A quantity of 70,000 cubic yards had to be dealt with, and the banks varied in height from 23ft. at the abutment end to about 12ft. where it joined the public roadway. These banks were constructed entirely by manual labour, as it was not feasible to introduce machinery. The labour was imported from Egypt, and the Khartoum bank was completed in April, 1926, with sufficient loose stone pitching placed to prevent any serious erosion during the flood. The bank on the Omdurman side was not completed until the following low-water season, and the whole of the earthwork and pitching completed before the flood season of 1927.

The first of the 16ft. diameter caissons was under air early in December, 1925, and the sinking continued without interruption until April, 1926, when it was necessary to abandon all work on the foundations until the following season. In all twelve caissons were sunk, and the pier shaft completed during the low-water season of 1925–26. Two complete organisations were worked simultaneously, one dealing with the piers on the island and on the Khartoum foreshore, which were all pitched on dry land, and the other with the caissons which had to be pitched and sunk in the river. All the caissons were sunk by means of compressed air. The locks used were of the latest type, capable of handling up to 150 cubic yards per twenty-four hours in soft material. The caissons had an average penetration of 5ft. into the rock. The excavation in hard material was very much slower and governed the time of the actual sinking operations. Steam power was used exclusively for the sinking plant. The power barges which accommodated the compressors, the steam electric lighting sets, and provided steam for the hoisting winches, consisted of two discarded gunboats, which, in their prime, had taken part in the naval operations in support of the forces under General—afterwards Earl—Kitchener at the battle of Omdurman. These power units were in duplicate, and could be conveniently moved and moored in the river in a position as near as possible to the caisson or caissons being sunk. The second season's work during the low-water period of 1926–27, included the remainder of the piers, viz., six of the 16ft. caissons and the swing caisson of 33ft. diameter. This season's work was not quite as large in volume as the first season, but presented certain difficulties in being further from the base, and deeper water and stronger currents were encountered. During work on the Western channel the river navigation had to be maintained, and provision had to be made against risk of damage to the permanent construction or to passing vessels. The last of the caissons to be sunk was the 33ft. diameter swing-span caisson, which was launched on February 1st, 1927, and both caisson and shaft were completed by the middle of April, 1927. The lower portion of this caisson is shown in half-cross section and half elevation in Fig. 8. It will be seen that the cutting edge proper consists of plate, 10in. wide and ¾in. thick. Five segments of this plate go to make up the circumference of the 33ft. diameter caisson. The ring thus formed is attached to the main shell of the caisson in the manner shown in the enlarged section—Fig. 9—a 4in. by 4in. by ⅜in. L section and ¾in. rivets, countersunk, being employed for the purpose. The shell plates, of which there are five to the round, are ¼in. thick. The pressure or excavating chamber, which is 8ft. deep, is lined with inner shell plates, 5/16in. thick in the manner seen in the engraving, and is heavily braced above its roof by steel angles. Two openings, one 3ft. 7in. and the other 2ft. 7in. in diameter respectively, were arranged—intersecting one another—for the fixing of the air locks. Circumferential stiffness was ensured by thirty radial angle iron girders. The roof plates were 5/16in. thick.

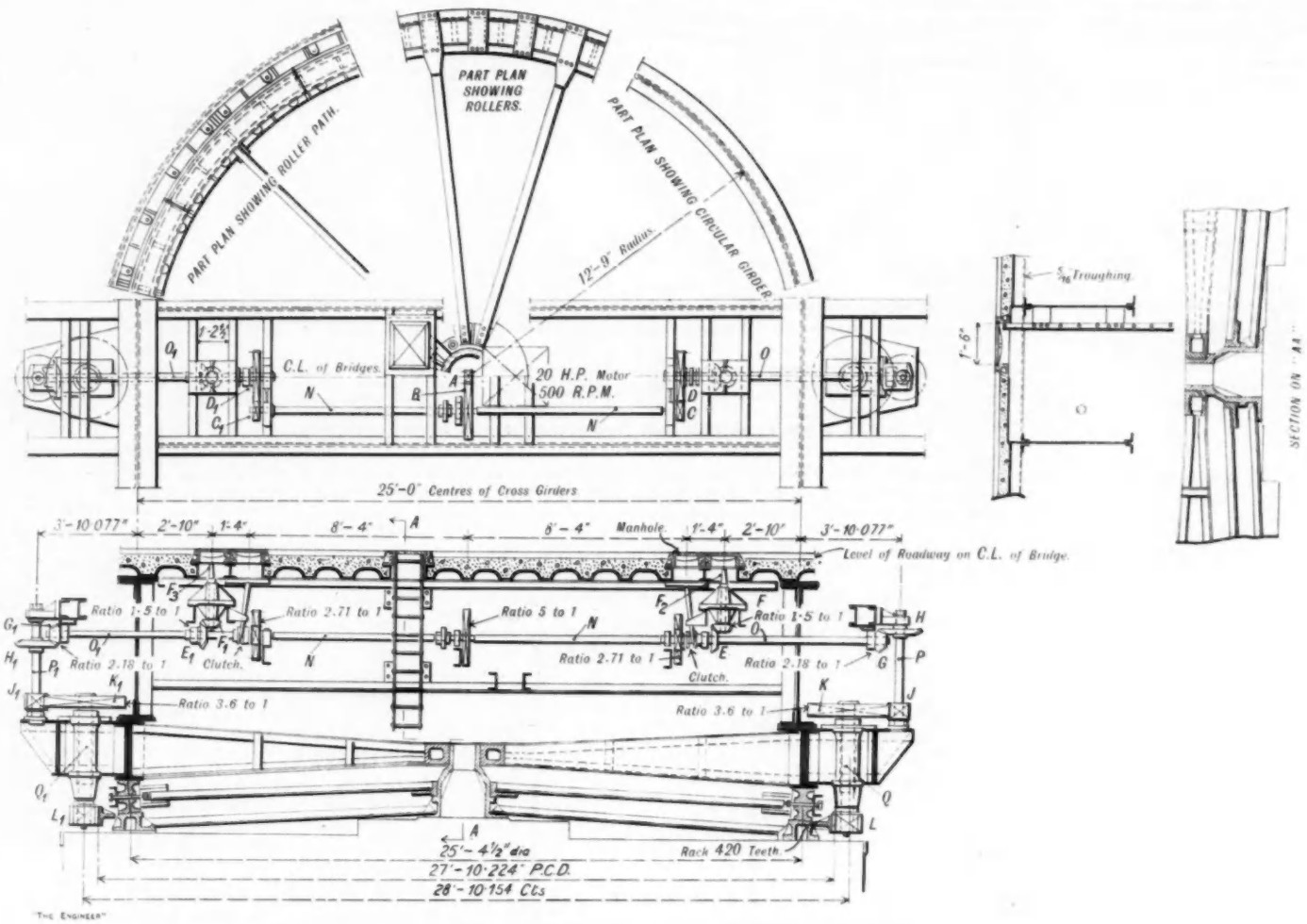

FIG. 7—ARRANGEMENT OF ROTATING GEARING OF SWING SPAN

The means adopted for the sinking of the caissons varied according to conditions. Those on dry land were assembled over their exact positions and concreted and sunk by cranes placed on a travelling steel staging, which carried all the air lock equipment and steam winches working the excavating cranes. This stage had to be about 15ft. above ground level to give the cranes sufficient headroom to lift the shafts into position, and also to place the concrete in the

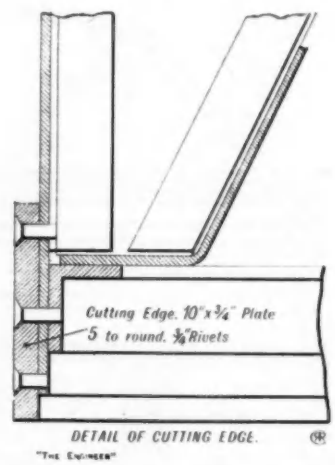

FIG. 9—CUTTING EDGE OF CAISSON

shafts. For the river piers piled stagings took the place of the steel travelling stage and fulfilled the same purpose. The lower sections of the river caissons were assembled on land, launched and floated into position in their stagings, but no pressure was taken on the stagings to keep the caisson in position while being pitched, this being provided for by special moorings operated by winches from above water, attachment of these moorings being so designed that they could be released as soon as the caisson was finally pitched and before excavation was commenced. This method was found much more reliable and more accurate than the usual method of supporting and wedging from the temporary stage. The large caisson for the swing span was pitched in 12ft. of water and had a total penetration of 17t., 8ft. of which was in solid sandstone.

As most of the work on the erection of the superstructure had to be carried out during the flood season, timber staging was adopted for the six eastern fixed spans—see Fig. 10. This staging consisted of bents at 30ft. centres formed of six piles abreast. Four of the piles carried the steel work, while the two outer piles, placed at 42ft. centres, carried an electric Goliath crane. These pile bents were headed with timber and securely braced with steel angles, but the longitudinals consisted of six lines of 24in. by 7½in. rolled steel joists, borrowed from the permanent steel work, with special junction pieces to bring the bearings exactly to 30ft. centres, being the centres of the bents. A view of the partly erected bridge, showing the Goliath, is given in Fig. 11.

The Goliath track joists carried no rails, as special wheels were provided on the Goliath to suit the upper flanges of these joists. The crane was electrically worked on all motions and current was collected from bare wires strung on the staging. As soon as the span was self-supporting the camber blocks were withdrawn and the timber utilised for re-driving, the steel work being brought under the Goliath by a temporary track laid on the spans which had been previously erected. The various members and pieces of steel work were carefully prepared and as much as possible of the field riveting completed in the yard before delivery to the erection Goliath; by this means considerable time and trouble were saved in the actual erection. The construction of the stage and its preparation for the Goliath occupied by far the longest time. Under favourable conditions a span could be assembled in just under five days, though sufficient time had to be allowed for riveting before the span was self-supporting and the staging could be relieved. The weight of steel work in each fixed span was about 400 tons.

As the navigable channel had to be maintained for steamer traffic at all times, the swing span was built in the open position, and for this span and also for the last or western fixed span a floating crane was used. This crane was a standard 7½-ton steam derrick with 120ft. jib mounted on two standard steel barges. The stagings used in this case were similar to those adopted for the seven fixed spans, but without the outer piles for the Goliath track. The swing span was designed without any compensation for distortion or error in level during construction and the minute adjustment which was found necessary when the span was completed and swung was made by means of lowering or raising the ends of the adjacent fixed spans. All the gear was completed by the time the steel work was erected and the span was rotated by hand until the roadway was completed and the electrical equipment installed.

On completion of the main members of the spans the troughing and the tramway track were placed, and the concrete and asphalt surface followed automatically. During the cool season of 1927 and 1928 the steel work of the swing span was completed and it was found that, owing to the sun temperature on the south main girder and the fact that the north bottom chord was in shade, the span distorted laterally about 1¾in. The maximum distortion occurred at 4 p.m. and disappeared during the night. This distortion, naturally, would affect both the wedging gear and the tramway track connection. After the placing of the concrete floor the distortion was reduced to §in., but even with this small deflection it was necessary to make provision at one end of the span to give the necessary clearance to the pins of the wedging gear and also to construct a special platform on the adjacent fixed span so that the alignment of the tramway track could be adjusted at any stage of the distortion.

As all the material used in the construction, with the exception of the sand, was delivered by rail a storage yard equipped with sidings and handling plant had to be provided. The steel work arrived from overseas in large consignments and as much as 2000 tons of steel work had to be stored. The nearest site to the works where sufficient space was available and which was not liable to inundation at high river level, was situated near the old steam ferry landing at Moghren, which was about 500 yards distant from the bridge site. The steel work was handled in the storage yard by an electric overhead crane carried on a gantry constructed chiefly of 24in. by 7½in. rolled steel joists, which were afterwards used in the floor system of the spans. A 7½-ton travelling Smith crane was also used for dealing with plant, caisson material and lighter steel work. The concrete aggregate, of which 12,000 tons had to be handled, was usually transferred from railway trucks to lighter wagons and hauled by a light locomotive to the site. A reserve of stone, however, had to be maintained in case of late deliveries from the quarries.

The broken stone for concrete, as well as most of the stone for pitching, was of granite obtained from the Gebel Royan Quarries situated on the main line about 40 kiloms. north of Khartoum. At the commencement of the construction there was no electrical power available from local sources, so that a small generating plant, consisting of duplicate Gardner Lancashire four-cylinder paraffin sets had to be installed. The engines were direct coupled to the dynamos on the same bed-plate and were capable of generating a total of 60 kW at 250 volts direct current, which was sufficient to drive the electric overhead crane in the yard and the Goliath crane on the bridge staging. A certain amount of current was also required for lighting and small power tools. All the lighting for the caissons, however, was generated from their own steam sets, the voltage being in this case 110 direct current. In this yard, also, the company's offices were established, as well as store sheds, workshops and other details incidental to a contract of this nature.

FIG. 11—BRIDGE PARTLY ERECTED SHOWING GOLIATH CRANE

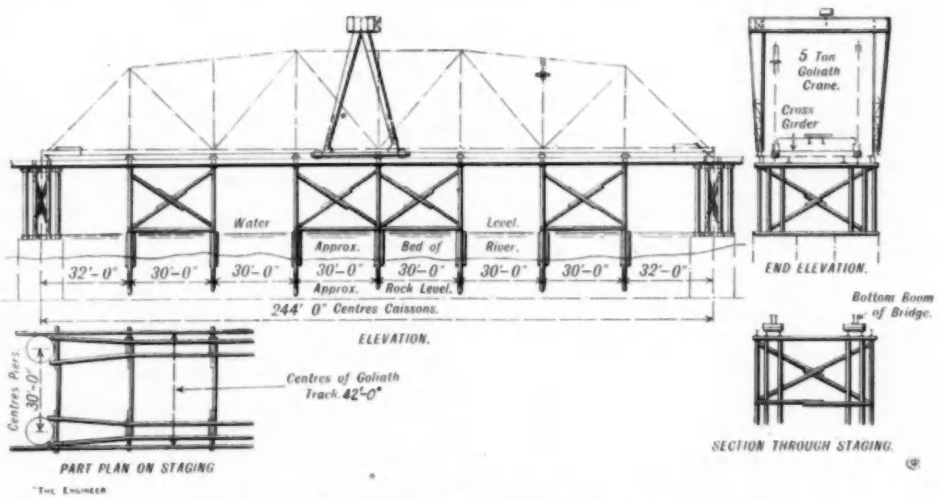

FIG. 10 STAGING FOR ERECTION OF FIXED SPAN

As already explained, the work on the foundations of the approach banks could be undertaken only during the winter or low water season, and was completed in two working seasons. The steel work, being independent of water transport, was carried on throughout the year, although during the summer work was slow and disagreeable owing to high temperatures, dust storms and the disadvantages encountered during a tropical hot weather season. The order for the construction of the bridge was placed in March, 1925, but no part of the permanent work could be commenced until December, 1925. In the interval, preliminary measures, such as housing for the staff, the assembling of plant, and the laying out of the yard and buildings were completed. The work on the permanent structure was actually commenced in November, 1925, and was carried on without interruption until the summer of 1926, when the general strike in this country delayed operations for about two months owing to shortage of steel work. In order that the completion of the bridge should synchronise with the putting in service of the first section of the electric tramways, certain subsidiary work had also to be completed, such as relaying of the tramway track on the Blue Nile Bridge and the construction of two small bridges crossing Khor Anga and Khor Fitihab in Omdurman. All these works were carried out by Dorman, Long and Co., Ltd.

The contract time allowed for completion was due to expire on June 30th, 1928, and the bridge was actually put into service on January 16th of that year, or about five and a-half months ahead of contract time.

The consulting engineers for the Sudan Government were Messrs. Coode, Wilson, Mitchell and Vaughan-Lee. The designs of the bridge were prepared by Mr. Ralph Freeman, M. Inst. C.E., who was consulting engineer to the contractors. Mr. F. W. Stephen, Assoc. M. Inst. C.E., acted as agent in charge of the construction.

The Construction of the "Grid" Transmission System in Great Britain.*

THE complete British grid system will comprise 2600 circuit miles of 132 kV overhead lines. The general construction of the "grid" will be dealt with in the following sections:—(A) Overhead lines; (B) sub-stations; (C) auxiliary equipment; (D) transformers. The general outlines of the grid design have been definitely decided upon after an exhaustive examination of all possible methods of construction. It is unlikely that the design will be fundamentally changed, although detail improvements will probably be introduced as experience accumulates.

(A) OVERHEAD LINES.

The operating conditions of the grid system are such that the variation from normal voltage does not usually exceed ± 5 per cent. The voltage to earth is maintained at a fixed maximum by directly earthing the neutral point of all transformers on the high-voltage side.

The general design of the lines complies with the regulations of the Electricity Commissioners, although the methods of satisfying the requirements of these regulations differ from those prescribed for lower-voltage systems.

In describing the transmission lines, the sequence will be—conductors, towers, and insulation.

Conductors.—The choice of conductor material rested largely on the mechanical properties of the available metals.

The difficulties which existed in obtaining wayleaves, and, in the case of sections of lines in towns, of getting tower sites, made it essential to be able to use spans of the maximum length.

Steel-cored aluminium conductors are decidedly the best which are available in this respect, at least so far as the initial properties of the material are concerned. A further advantage of steel-cored aluminium conductors is the protection afforded by the steel core against burning

* Abstract of paper read by Messrs. Johnstone Wright and C. W. Marshall before the Institution of Electrical Engineers.

through in the event of a flash-over. The ability of aluminium and steel to maintain their mechanical strength and electrical conductivity is much more open to controversy than are their initial qualities, but extensive experience has shown that the steel core of an aluminium-steel conductor is completely protected from the atmosphere so long as the aluminium remains sound. The life of aluminium is therefore the principal criterion of the life of the conductor. Many quantitative tests on rate of depreciation or deterioration of aluminium have been made, the best-known tests being probably those of Professor E. Wilson, of King's College, London. Professor Wilson found that pure aluminium wires, after exposure to London atmosphere for a period of twenty-four years, had lost 10 per cent. of their conductance and 9·5 per cent. of their mechanical strength.

The standard line conductor consists of a central core

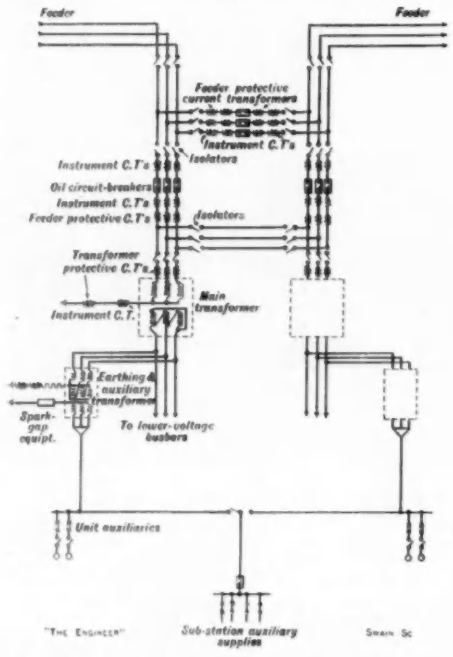

FIG. 1—CONNECTIONS FOR THREE-CIRCUIT-BREAKER SUB-STATION

of seven strands of galvanised steel wire, each 0·11in. diameter, surrounded by thirty strands of aluminium wire of the same diameter. The conductivity is equivalent to that of a copper conductor of 0·175 square inch cross-sectional area. The overall diameter is 0·77in. This conductor has been chosen as the most economical one to satisfy the electrical and mechanical loads on the lines. The capacity of a single-circuit line is 50,000 kVA and the current corresponding to this at 132 kV is 219 ampères. The current-carrying capacity of the conductors from a temperature-rise standpoint is much in excess of this figure, but the corona-loss requirements made it necessary to have a comparatively great overall diameter. This consideration and mechanical requirements were prime factors in making the ultimate choice. The critical corona voltage for the conductors under normal atmospheric conditions is approximately 184 kV, and the corona power losses are accordingly negligibly small.

The number of joints is kept as low as possible. Wherever practicable the joints are located at tension towers, but jointing in the spans is resorted to when required, and, in practice, nearly all joints will be in the spans. The mechanical strength of the joints is not less than 95 per cent. of the strength of the conductor itself, and their conductivity equals or exceeds that of the conductor. In jointing, the steel and aluminium are connected separately and the joints are sealed. The earth conductor has seven steel and twelve aluminium strands, all 0·11in. diameter. The earth wire serves as an electro-static screen as well as providing a low-resistance path for returning fault currents. Its characteristics are very different from those of the comparatively high-resistance steel wires which are usually employed on power lines, and, in view of the widely divergent opinions on the relative importance of the functions to be performed by earth wires, it will not be possible to demonstrate whether or not the extra expense is justified until actual experience has been obtained. The protective value of aluminium stranding against corrosion of the steel is further justification for its use.

Towers.—An examination of existing transmission systems will show that there is nothing approaching uniformity of opinion as to what constitutes the best outline design to be adopted for towers.

Steel, reinforced concrete, and even wood, have been used as tower construction materials for high-voltage lines, but for towers of the height and strength required for the grid lines, there is no doubt of the superiority of steel.

The broad classification is according to the disposition of the conductors, *i.e.*, whether triangular or rectilinear. With single-circuit towers electrical symmetry can only be obtained by threading one conductor, and this gives rise to somewhat expensive conductor erection costs.

The choice of narrow-base or broad-base towers depends

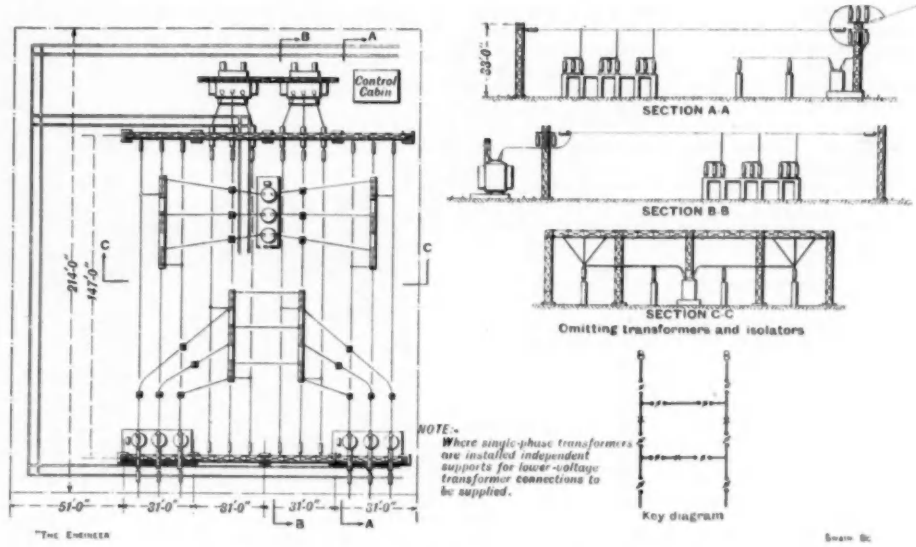

FIG. 3—TYPICAL LAY-OUT FOR "L.E." SUB-STATION

largely on way leave considerations, although for any given stress and height conditions there is a corresponding most economical base area.

Æsthetic considerations played a considerable part in the choice of wide-base towers for the grid, and this consideration was also instrumental in eliminating the horizontal arrangement of conductors.

The standard tower types used in the construction of the grid have been designed with a view to meeting all requirements as to ground conditions and economics with a minimum number of types.

The normal span length is 900ft., but all standard angle towers are so designed that, when used with corresponding maximum angles of deviation, the sum of two adjacent spans may total 2000ft. under favourable ground contour conditions. The contour dimensions are determined broadly from the clearances which have been specified. The clearance of the lowest line conductor to earth at a temperature of 50 deg. Cent. is 22ft., while over buildings the minimum clearance is 8ft. The vertical distance

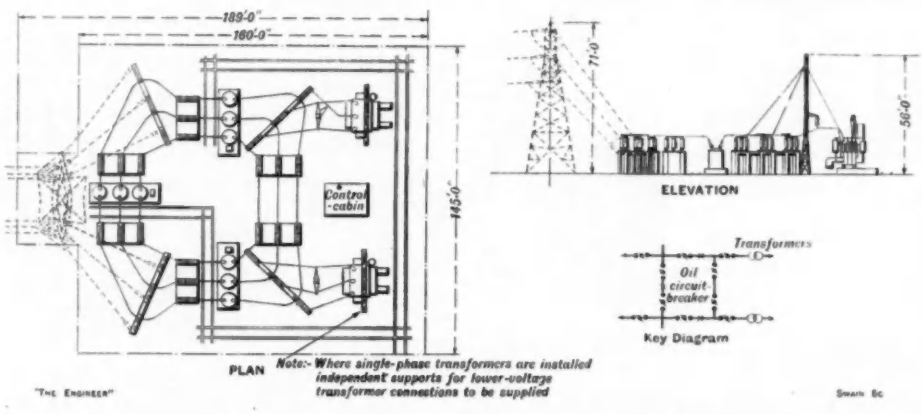

FIG. 2—TYPICAL LAY-OUT FOR "L.N.E." SUB-STATION

between conductors is 12ft., and the projected horizontal distance is 3ft. The minimum normal clearance between live metal and the tower steel work is 3ft. 6in. under the worst conditions of line displacement. Provision has been made for adding to the number of insulator units without encroaching on the main clearances. This allowance is made to cover any specially difficult atmospheric conditions which may be encountered.

Three types of foundations, viz., excavated earth, concrete ball, and ordinary concrete, are used, the type chosen depending on the nature of the sub-soil in which the tower stands and also on the relative costs.

The concrete ball foundation is new to Great Britain, but it is widely used in America. In addition, tests have been made on behalf of the Central Electricity Board to establish the conditions which determine in what circumstances foundations of this type are suitable. The concrete ball foundation is made by drilling a cylindrical hole for each tower leg and expanding the lower end of the hole to a spherical form by exploding a charge of dynamite in it. The tower leg stubs are fitted into position by means of a template, and the cavities are filled in with concrete. The operation is simple, accurate, and economical.

Loadings.—The assumed working loadings on the towers are as follows :—

The vertical load is made up of the weights of the conductors, together with a coating of ice of ½in. radial thickness, and the weights of all insulators and fittings. The transverse load is that due to (1) a wind pressure of 8 lb. per square foot on the whole projected area of all conductors when coated with ice ; (2) the horizontal resultant of the conductor tensions ; and (3) a wind pressure of 25 lb. per square foot on 1¼ times the projected area of the members of one face of the towers. The longitudinal loadings are those impressed by the conductor tensions. These conditions are more severe than those called for in the recently revised regulations of the Electricity Commissioners.

It is further assumed that the towers may be subjected to additional stress due to conductors breaking. The straight-line towers are capable of withstanding the additional stresses due to the breakage of any single conductor. The medium-angle and large-angle towers on single-circuit and double-circuit lines can withstand the additional stresses caused by breakage of any two and any four conductors respectively.

The factor of safety against tower or foundation failure is 2·5 when the stresses correspond to the maximum loading conditions with unbroken conductors, but under maximum loadings and broken conductor conditions the factor of safety is 1·5.

The tower material is mild steel to the requirements of British standard specification No. 15.

The minimum allowable thickness of main structural members is ⅛in., and of other members ⅛in.

The designs are such as to reduce to a minimum the number of different sections used, and care has been taken to ensure that the highest degree of accuracy in manufacture is attained. The steel is galvanised by the "hot" process, the zinc coating being 2 oz. of zinc per square foot of surface. Other methods of protecting the steel from corrosion are also being investigated. Where concrete ball or concrete block foundations are used, the towers are earthed by means of galvanised iron pipes, 6ft. long, 6in. diameter and ⅛in. thick.

The principal steps which have been taken to provide a final check on the towers are inspection of material during manufacture, tests of samples of steel and tests on the towers themselves. Tests on the actual towers are essential because, although it is possible to determine the stresses in each member by analytical or graphical methods, the uncertainties introduced by slight manufacturing inaccuracies and by incomplete rigidity of foundations, somewhat invalidate the results of calculations.

The testing procedure which has been adopted is to apply static loads which accurately represent the load due to wind, ice, conductor breakages or combinations of these conditions. The vertical loads are applied by direct loading. The horizontal loads are applied by means of hand winches, the magnitude of the horizontal forces being measured by dynamometers placed in the cables between the towers and the winches. The deflections and strains corresponding to each particular load are measured and the readings of stress and strain so obtained give a good indication of accuracy of workmanship, as well as of the adequacy or otherwise of the members of the structure.

As a final precaution, sample towers are tested to destruction. The forces required to destroy the structures establish definitely the factors of safety which have been obtained.

It is fully recognised that towers will in practice be subjected to varying stresses, and that the static load tests do not exactly represent working conditions. The relations between alternating and static stresses are, however, well known, and it is felt that the tests which have been carried out provide a sufficiently accurate guide to the behaviour of the towers in pratice.

The "Grid" Protective System.—Experience has shown that well-built high-voltage transmission lines are very free from operation troubles in comparison with lower-voltage lines. The reasons for this immunity from faults are the stronger mechanical construction and the very large spacing of the lines, which eliminates trouble due to birds, branches and, in some cases, lightning. It has been possible in many cases to give very satisfactory service without the use of protective gear other than overload relays. Modern conditions, however, demand absolute continuity of supply, and in order to attain this, some form

of selective protective gear must be installed on all interconnected systems.

British experience with discriminative protective gear on systems of comparatively small power and working at voltages up to 33 kV, has, on the whole, been quite successful. It would therefore appear that existing types of protective gear could safely be adopted for the grid. There are, however, many difficulties peculiar to high-power, high-voltage systems. The power arcs which occur during short circuits produce extremely destructive effects on conductors and insulators, so that the need for the rapid switching-out of faulty sections is very insistent. For the same reason, it is advisable, if at all possible, to increase the current sensitiveness of any protective device to be used.

Two courses of action were open, either (1) to use a pilot system in accordance with British practice, or (2) to follow American and continental methods of protection not involving the use of pilot wires. It had to be borne in mind that no precedent exists for the use of pilot-wire protection in a high-tension system of any magnitude, and that the grid-switching arrangements make it unusually difficult to ensure balance between the two ends of a line section. The ordinary pilot-wire schemes also suffer from serious disabilities as regards high cost and vulnerability of pilots, especially on long line sections. They have, on the other hand, the great advantages of rapid action and ease of maintenance, due to the construction and characteristics of the relays being simple. The fact that pilot schemes do not in general require potential transformers is also greatly in their favour, although the compensated-secondary potential transformers which are now used to reproduce primary voltages nullify this advantage to some extent. The final result of the investigation of the various alternative schemes examined was that pilot-wire systems offer the best probability of obtaining rapid and sensitive discriminative protection, but that the cost of pilots is not justifiable on long lines where other forms of protective gear can give almost as good results. Impedance or reactance relays are the only alternative at present available, and these are being used on the long sections of the Scottish lines.

The protective systems so far discussed refer to those which operate owing to excessive or incorrect flow of current. With numerous cable systems, it is generally unnecessary to proceed further. With overhead systems consideration must be given to other phenomena which may cause trouble, *e.g.*, the abnormal increases of potential which occur due to lightning and abrupt load changes. Great diversity of opinion exists as to the best methods of guarding against troubles from these sources. As a result of an examination of all the available devices, it was finally decided to rely on a high-conductivity earth wire, provision of arcing rings and horns, reinforcement of transformer end turn insulation, and earthing of the neutral point for the protection of the grid against surges. The earth wire serves the double purpose of acting as a definite return for fault currents and as an electro static screen to reduce voltages induced by lightning. The arcing horns and rings give a definite path for transient discharges, and protect the insulators and conductors from the effects of power arcs. Laboratory tests indicate that the horns and rings as used on the grid give very complete protection to the strings under dry weather conditions, and that the only time when there is a tendency for the arc to spread to the insulators or the conductor is during wind and rain. No lightning arrestors will be used in the first instance, as it is considered that the comparatively small number of lightning storms which occur in Great Britain does not endanger the "grid" to such an extent as to justify their provision. It is, further, at least controversial whether lightning arrestors are justified in any circumstances. In order to gain experience as to the exact effects of lightning on transmission lines, klydonographs will be installed at specially exposed points in order to measure the voltages which are actually induced.

SUB-STATIONS AND SWITCHGEAR.

To meet the load requirements and to accommodate the gear to site conditions, six basic types of outdoor sub-stations were designed. The diagram of connections giving the principal components of the stations is shown in Fig. 1. The types of stations are designated as follows :—

L.N.E. ..	Three-circuit breaker, non-extensible	Low type
H.N.E. ..	Three-circuit breaker, non-extensible	High type
L.E. ..	Three-circuit breaker, extensible ..	Low type
H.E. ..	Three-circuit breaker, extensible ..	High type
L.D.B. ..	Double bus-bar	Low type
H.D.B.	Double bus-bar	High type
C.	Connections only between transformers and feeders	

Key diagrams of connections and typical lay-outs for each of these types are shown in Figs. 2–7. The type L.N.E. station provides switching arrangements for two 132-kV lines and two transformer banks, and it has a by-pass connection to enable each transformer bank to operate from either of the supply lines.

The by-pass connection is normally kept open, and one transformer switch and the section switch must open automatically in the event of a fault occurring in either a line or a transformer. This arrangement utilises the minimum of apparatus consistent with rapid resumption of service after a fault. It has been chosen in preference to the more usual lay-out in which a circuit breaker is installed on each feeder, in addition to those included in the design under consideration, because of the saving in cost, the reduction of maintenance charges, and the decreased number of danger points brought about by the simplification.

The L.N.E. type of station is used in situations where no provision for future extension is considered necessary.

Designs L.E. and H.E. provide the same switching facilities as design L.N.E., but the lay-out of the apparatus is such as to make extension of the number of circuits comparatively simple. There is no essential difference between the two designs. Choice of design in any particular case depends entirely on site conditions. These types can be modified and extended to types L.D.B. and H.D.B. The extended sub-stations include duplicate bus-bars and oil switches on each of the feeders. The H.D.B. arrangement is so designed as to reduce to a minimum the floor area required. It involves a greater amount of structural steel and increased height, so that inspection and maintenance are made somewhat more difficult. It is used only where the space necessary for the L.D.B. type cannot be obtained.

The C type station only makes provision for terminating the 132-kV feeders and for connecting them to the transformers.

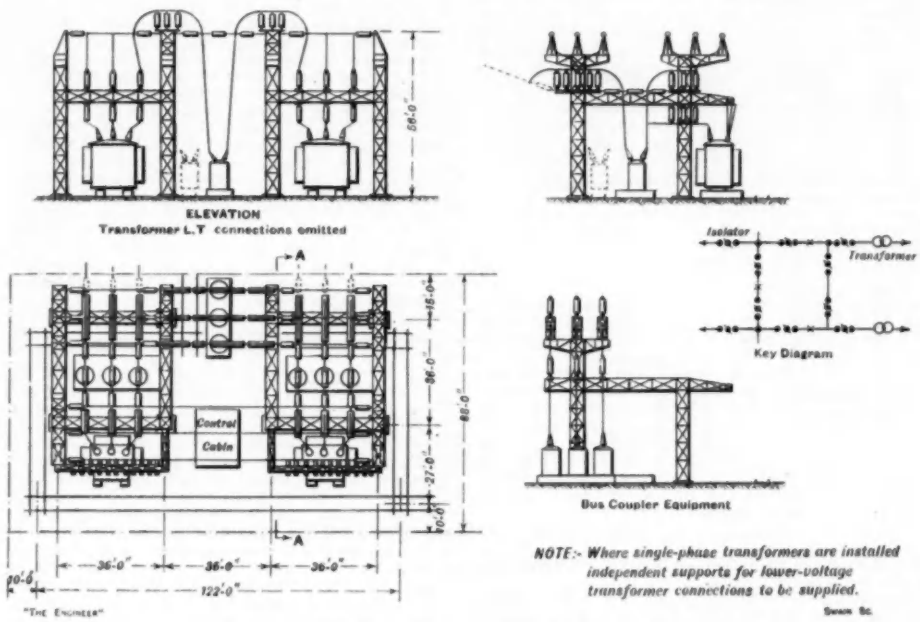

FIG. 4—TYPICAL LAY-OUT OF "H.E." SUB-STATION

AUXILIARY EQUIPMENT.

The Operation of the Grid System.—One of the most important factors which comes into the complex problem of the construction of the grid is the provision of adequate means for operating stations efficiently under all conditions of loading.

In the earlier stages each section, such as Central Scotland, South-East England, or Central England, will function as a separate unit. The district engineers will be in general control and all operations will be done by local operating engineers in accordance with their decisions. There will be a central point in each district from which all operations for that district will be carried out or supervised. Each district control engineer will have telephonic communication with all power and transforming stations in his area. A special control room will be provided in each area, and in this all the apparatus necessary for guiding the engineers will be located. The indications which are considered to be essential to the control engineer in a particular district are summarised briefly by giving the readings which are provided for him by all stations. They are as follows :—

(1) The operating positions—whether open or closed—of all circuit breakers, isolating switches, and earthing switches.

(2) The transformation ratio in use on each transformer bank.

(3) The load which is being imported by or exported from each station, together with the current and power factor.

(4) The current, voltage, and power factor in each feeder circuit.

(5) The plant in operation and available for operation.

The operating positions of the 132-kV line and sectioning circuit breakers will be transmitted automatically to the central control room, but no automatic indications of the isolating and earthing switches will be provided, as operation is purely a local matter, and any sudden abnormality is sufficiently indicated by the load variations accompanying it.

The isolating switches will usually be operated only after communication with the control engineer, who will thereafter register their positions on his diagram. In the event of a local engineer being forced to operate such switches on his own initiative, due to emergency conditions, he will notify the control engineer of the alterations made.

The load-indication instruments show the power and the wattless component of the power in each circuit. High precision is not aimed at in these, but the instruments will be sufficiently accurate and sensitive to show any important change in operating conditions.

The transmission of automatic indications from remote points will be accomplished through telephone pilot wires in the sections of the grid which are at present being constructed ; the possibilities of transmitting such indications by carrier-current systems are not being neglected.

A standard control house has been designed for all district sections. No apparatus for actually controlling the power plant and equipment is housed in this building, as the function of the control engineer is to direct the operating engineers in the power stations and sub-stations. The operating engineers will retain direct control of the plant, as at present. The operating records and statistics, as well as the meter readings required for accountancy purposes, will also be kept at the control rooms.

TRANSFORMERS.

All transformers on the 132-kV system are designed for outdoor working. No special requirements were made as to whether core or shell construction should be adopted, and in practice both types will be used. Single-phase or three-phase units are used, according to the capacity required. Transformers of 30,000 kVA or less are of the three-phase type, while those of higher capacity are made up from single-phase units. The standard capacities to be used are 7500, 10,000, 15,000, 20,000, 30,000, 45,000, 60,000, and 75,000 kVA, the ratings being in accordance with the recommendations of B.S.S. No. 171, 1927. These capacities were decided on after consideration of the interchange of loads between all power stations on the grid system and of the load requiremnts at points where no generating plant is operated. The cooling system adopted depends on the capacity of the units. Natural cooling is used on the smallest transformers. Larger transformers have natural cooling up to half load or slightly more, while at higher loads forced air blast cooling is used. The air blast may be applied directly to the radiators on the transformer tanks or to separate coolers with forced

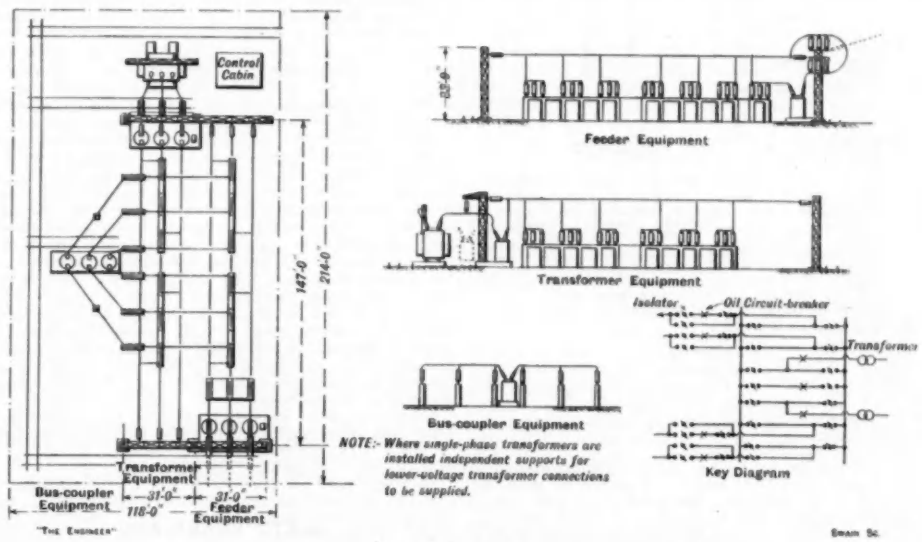

FIG. 5—TYPICAL LAY-OUT OF "L.D.B." SUB-STATION

oil circulation. This cooling system is a definite departure from existing British practice and has marked advantages over the better-known schemes such as water cooling. The auxiliary cooling plant operates only under emergency conditions, and the risks due to corrosion or leakage are reduced. The only apparant disadvantage of the forced air cooling scheme is a tendency to noisiness, but every care has been taken to ensure that the operation will be as silent as possible.

The 132-kV windings are star-connected, the neutral point being connected permanently and directly to earth. The lower-voltage windings are delta connected. In some cases the lower-voltage windings are in two parallel sections so as to provide two secondary pressures.

The great power capacities of the sections of the grid give rise to very high short-circuit currents and mechanical stresses in the windings. To meet these conditions, the transformers have high impedance, and their windings

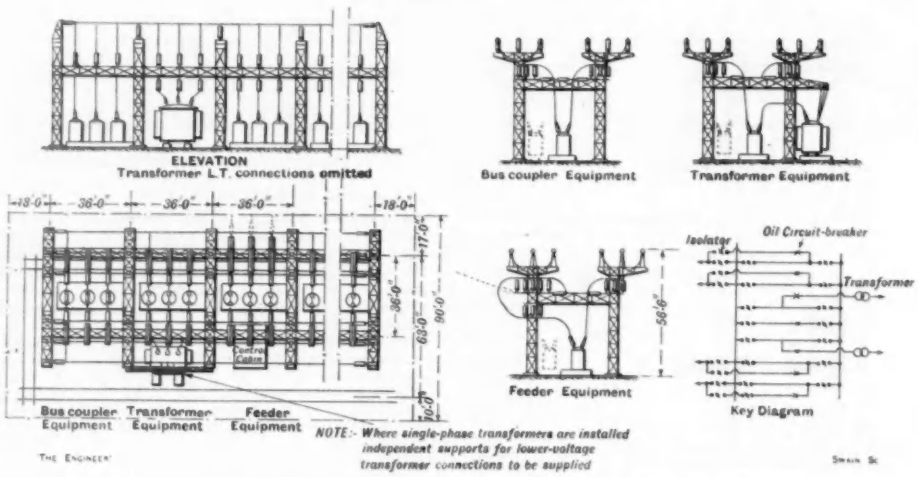

FIG. 6—TYPICAL LAY-OUT OF "H.D.B." SUB-STATION

are very strongly constructed and supported. Adjustable clamps are provided to take up shrinkage of the insulating material.

Voltage Regulation.—All transformers are provided with voltage-regulating equipment, which can be operated under load. The specification calls for variations of transformation ratio of ± 10 per cent. from normal in steps of not more than 1·43 per cent. There is no restriction on manufacturers regarding the methods whereby the regulation is carried out, other than the requirement that no phase displacement will be produced. Automatic interlocking gear is provided to ensure that all grid transformers in a particular sub-station will be at the same transformation ratio before they can be paralleled.

Insulation.—The thermal requirements as to insulating materials are that they will be able to withstand the effects of contact with oil at 95 deg. Cent., continuously or at 110 deg. Cent. for short periods. One per cent. of the turns at each end of the phase windings are insulated to withstand full line voltage between turns for three

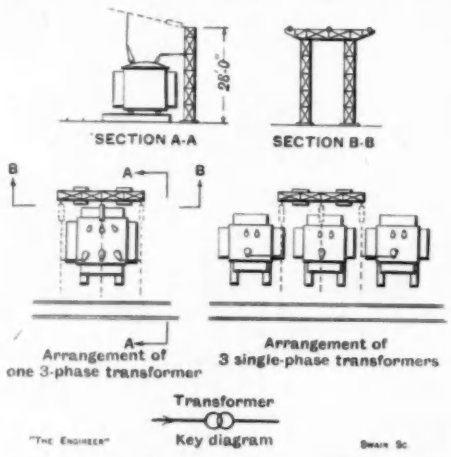

FIG. 7—"C" TYPE SUB-STATION

seconds. The next 4 per cent. of the turns are graded so that at 5 per cent. of the number of turns from each end the insulation can withstand one-third of full line voltage for three seconds. The remainder of the winding is, except at tappings, insulated to withstand one-fifth of full line voltage for the same period. The insulation between turns of the tapped coils and 3 per cent. of the windings on each side can withstand one-third of the full line voltage between turns.

The terminal bushings are so designed that no appreciable corona appears until the applied voltage exceeds 1·4 times the rated pressure. They can also withstand, when dry, a test pressure of 300 kV for one minute when mounted as in service with their lower ends in oil. Arcing rings are fitted to allow of flashing-over without damage to the porcelain and conductors. Flexible connections are used between the bushings and the windings, so as to avoid damaging the bushings if there is any relative movement between them and the transformer. No special preference is given to either condenser type or plain oil-filled bushings, but all types used in any particular schemes are mechanically interchangeable.

In specifying the construction of the magnetic circuits, the main requirements have been to ensure that the flux density is low and that there shall be no undue vibration or noise. Very great care has also been taken with the mechanical construction and insulation of the core laminations and structural framework to avoid trouble due to circulating currents.

Transport considerations made it necessary to use extremely robust tanks, as each transformer has to be capable of being transported complete with oil by rail, road or sea. The radiators are, of course, transported separately. For convenience in getting transformers into position at the sub-stations, the tanks are fitted with flanged wheels, the gauge being 4ft. 8½in. These wheels can be turned through 90 deg. when the transformer is jacked up. Lifting eyes and lugs are fitted for handling the transformers by means of cranes or jacks.

Conservator tanks, fitted with calcium-chloride breathers are provided to ensure that there shall be no danger of moisture getting to the oil. Provision is made for fitting Buchholz relays in the connector between the conservator and the main tanks.

The indicators provided for the guidance of the operating engineers are an oil-level gauge fitted to each conservator, and two temperature indicators fitted to each transformer. The temperature indicators register the temperature of the oil near the top of the transformer and the highest temperature within the transformer windings. There is also an alarm device which gives warning in the event of the winding temperature reaching 100 deg. Cent. or other predetermined value, and which closes the tripping circuits of the circuit breakers controlling the transformers if the winding temperature rises more than 10 deg. Cent. above the temperature at which the alarm is given. The oil used is as defined in B.S.S. No. 148.

Except at three-shift power stations, where permanent earthing facilities exist, a separate earthing transformer is provided for the secondary side of each 132-kV transformer. This transformer has a main interconnected star winding, which is directly connected to the lower-voltage side of the power transformer, and an auxiliary star-connected winding to give 400 volts, three phase, and 230 volts, single phase. The neutral point of the earthing transformer primary is earthed through a resistance.

The earthing transformer can carry the full auxiliary load of the station auxiliary motors and lighting system continuously, and can, in addition, carry any earth fault current for fifteen seconds. The earth fault current is of the order of 400 to 900 ampères. The capacity of the auxiliary windings is 100 kVA, plus the kVA required for the station auxiliaries.

In view of the vital importance of the transformers and of the difficulty of rectifying any error on site, a very comprehensive series of tests has been arranged. The standard schedule includes tests on sample coils, transformer temperature-rise tests, pressure tests on electric and magnetic circuits, bushing tests on control apparatus, short-circuit tests, oil tests, and tank and cooling plant tests. Most of these tests are too familiar to require further mention, but the following notes may be of interest. The pressure test on the main windings is conducted by inducing a voltage of 2·73 times the service voltage in the windings. This test must be made at high frequency to keep the magnetising current sufficiently low. As a type test, the voltage control apparatus is operated 2000 times, and the contacts are tested five times at ten times rated current for a period of two seconds.

Technical data regarding the actual transformers to be used in Scotland are included in Part II. of the paper.

SIXTY YEARS AGO.

ON December 9th, 1868, after a period of much electioneering excitement, Disraeli's short-lived Government, which had ruled the country only since February of that year, was turned out of power, and a new Liberal Government set up in its stead. It was Gladstone's first Government, with himself as Prime Minister. One of the first duties which it set itself was to remove from the public offices all those whom it thought superfluous. No one in the Civil Service felt entirely safe. Ruthless reformers were at work, and were sweeping away temporary clerks in scores, and threatening the existence of entire classes. The people and the Press seconded the Government's efforts, and according to a leading article in our issue of January 29th, 1869, even demanded that the official programme of reform should be exceeded. The zeal displayed by the popular reformers carried them so far as to attack the inspectors of factories. These inspectors, it was urged, were altogether unnecessary. Their work, certain sections of the Press alleged, could be equally well done by the health officers. We very heartily disagreed with that view. Not even to secure so grand an object as the extinction of a few salaries of a few hundred pounds could we coincide with those writers who recommended the abolition of the factory inspectors' department. Acts of Parliament, we wrote, could not insure good wages nor open the doors of cotton mills closed by famine. Legislation could, however, prevent a few pitiless and grasping slave-drivers from forcing the pace at which "hands" were worked, and, by the terrible threat of dismissal, from causing their people to work themselves to idiocy or death. The rigour of the hard conditions on which factory operatives held their lives had been mitigated, so far as it could be mitigated, by legislation. We fully believed that the large majority of manufacturers would of their own free will, if it depended entirely upon themselves, adopt all merciful regulations in their power. It was necessary, however, to protect the manufacturer from competition, just as it was to protect the workers from tyranny. It was essential that good masters and conscientious men should have fair play, and that hard masters and pitiless drivers should not be allowed to get an unfair start. A great temptation to encroach in various ways on forbidden ground was placed before manufacturers, and nothing short of a very complete system of inspection could guard against the violation of the Factory Acts. Who, we asked, was to be the accuser of a mill-owner who, during a period of pressure, was tempted to gain an advantage for himself by disregarding prohibitions in these Acts? Would his workpeople venture to prosecute? And who but they, if he were relieved of the inspector's visits, would know anything about his proceedings? The factory inspector's office was one of considerable trust, and it would, we concluded, be very bad policy to treat it with apparent contempt.

THE INSTITUTE OF METALS.

THE twenty-first annual general meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W. 1, on Wednesday and Thursday, March 13th and 14th, and on March 13th the annual dinner of the Institute will be held at the Trocadero Restaurant, Piccadilly-circus, W. 1, at 6.45 for 7 p.m. The dinner will be followed by a dance, ending at midnight. To celebrate the "Coming-of-Age" of the Institute a conversazione will be held at the new Science Museum, South Kensington, in the evening of March 14th, in connection with which a metallurgical exhibition is being arranged.

The following programme has been arranged:—On Wednesday, March 13th, at 10 a.m., a general meeting will be held in the Hall of the Institution of Mechanical Engineers, and there will be an afternoon session from 2 to 4 p.m. At both sessions papers will be read and discussed. On the Thursday there will also be two sessions, the first from 10 a.m. to 1 p.m., and the second from 2 p.m. to 4 p.m., when further papers will be dealt with. In the evening from 8 p.m. to 10 p.m., there will be a Conversazione and Exhibition at the Science Museum, Exhibition-road, South Kensington S.W. 7.

The following papers are expected to be submitted:—

D. F. Campbell, "Recent Developments in Electric Furnaces"; W. Rosenhain, D.Sc., F.R.S. and W. E. Prytherch, "An Improved Form of Electric Resistance Furnace"; G. B. Brook and G. H. Stott, "Note on the Testing of Electro-deposits on Aluminium"; H. C. Lancaster, "The Importance of Design, and Setting of Large Kettles Used for Refining and Low-melting Point Alloys"; Clement Blazey, "Brittleness in Arsenical Copper.—II."; Professor P. Saldau, "Special Properties of Eutectics and Eutectoid Alloys in Binary Metallic Systems"; F. Hargreaves and R. J. Hills, "Work-softening and a Theory of Intercrystalline Cohesion"; Marie L. V. Gayler, D.Sc., and G. D. Preston, "The Age-hardening of Some Aluminium Alloys"; P. J. Durrant, Ph.D., "The Constitution of the Cadmium-Rich Alloys of the System Cadmium-Gold"; W. Hume-Rothery, Ph.D., and E. Rounsefell, "The System Magnesium-Zinc"; C. Sykes, "Alloys of Zirconium.—II."; J. Newton Friend, D.Sc., Ph.D., and W. E. Thorneycroft, "The Resistance of Zinc to Indentation (A Preliminary Account)"; J. Newton Friend, "The Solution of Plain and Amalgamated Zincs in Electric Batteries"; J. Newton Friend and W. E. Thorneycroft, "The Silver Contents of Specimens of Ancient and Mediæval Lead"; and P. J. Durrant, Ph.D., "A Note on the Haughton-Hanson Thermostat. A Method of Fine Adjustment."

B.E.S.A. SPECIFICATIONS.

TUNGSTEN FILAMENT ELECTRIC LAMPS.

THE British Engineering Standards Association has just issued a revision of the British Standard Specification for Tungsten Filament Electric Lamps (No. 161–1928).

The chief features of this revision are the reduction in the tolerances allowed on the light centre lengths and, for lamps up to 100 watts, the light centre lengths themselves have been reduced. The overall length of the lamp and the maximum neck diameter, together with the distance from the contact plate of the cap at which the measurement of the neck diameter is to be made, are also given. These changes will be of great assistance to the manufacturers in designing fittings. The light output of lamps and efficiency are now given in terms of lumens only, excepting that in addition to the lumens output the nominal mean spherical candle-power output is given. In former editions only maximum diameters of gas-filled lamps were given. In this revision the actual diameters (with tolerances) are specified for all sizes up to 100 watts. A change has been made in regard to the rating of vacuum traction lamps (series burning), the ampères at rated voltage being now adopted as a standard in place of volts at rated current.

Copies of this specification, No. 161–1928, may be obtained from the Publications Department, British Engineering Standards Association, 28, Victoria-street, London, S.W. 1, price 2s. 3d. post free.

Railway and Road Matters.

ARRANGEMENTS are being made for the construction of a railway from Kalgan to Dolo, Nor, Inner Mongolia.

AN official notification has been issued authorising the electrification of the Central Argentine Railway in accordance with the proposals of the company.

THE making of ferro-concrete posts for signals was mainly a result of the war, and achieved no little success. Experience on the Great Western has not, however, been wholly satisfactory, and steel tubes are now being tried, but only for signals 24ft. or 26ft. high. Timber is preferred for higher signals and for those carrying brackets.

THE provision by the London and North-Eastern Railway of electrically-operated carriage-washing plant at Ilford and Cowlairs was mentioned in this column of our issue of August 10th last. It is now announced that apparatus of an improved design is to be erected at York, Craigentinny, Bridgeton Cross and Heaton. Each carriage is washed in 1¼ minutes.

OUR attention has been drawn to the paragraph which appeared on page 45 of the issue of THE ENGINEER dated January 11th, in which it was stated that Mr. E. H. d'E. Darby had been transferred to Derby to succeed Mr. J. Briggs. It should have been said that Mr. Darby's appointment there was consequent upon the retirement of Mr. H. P. Miles, formerly divisional engineer for the Eastern Division of the railway.

THE Marlborough branch of the Great Western Railway runs from Savernake on the Berks. and Hants. line. It was opened on April 15th, 1864, and is to be closed on April 1st next, and a motor-omnibus service provided instead. Marlborough will, however, still have railway communication, as it is on the former Midland and South Western Junction, which, under the grouping scheme, became part of the Great Western.

THE coroner's inquest into the four deaths resulting from the Ashchurch collision of January 8th was concluded on Friday, January 25th. In its original verdict the jury added a rider condemning the system of signalling as "faulty," but on the coroner's representation it amended the rider so as to recommend that the railway company should be asked to consider whether a speedier system of calling out the fogmen could not be adopted.

THE subject of steel sleepers cropped up in Parliament before it was adjourned. Answering a question by Commander Bellairs, the Minister of Transport said that he understood that the railway companies viewed with sympathy the suggestion that steel sleepers should be used wherever possible, provided that their particular requirements could be met, and that the railways were at present undertaking tests on various sections of their lines.

THERE was another serious level crossing accident on the evening of Wednesday, January 23rd, but fortunately no one was killed. In this case the railway is a mineral line near Newcastle, where the wagons are conveyed by wire ropes. Moreover, the crossing is protected by gates. In consequence of the approach of a string of wagons the gates were across the road, but the driver of an omnibus running between Newcastle and South Shields allowed his vehicle to break through the nearer gate and to foul the railway. The omnibus was so damaged that it could not back clear.

IT may be remembered that in 1927 the Tilmanstone (Kent) Collieries, Ltd., after successful opposition by the Southern Railway and other interests, eventually obtained an Order to make an aerial ropeway from the Tilmanstone Colliery to Dover Harbour. Most of the work has now been done, but the company wishes to divert the intended line at one point and to carry it through two tunnels under Dover Cliffs. The tunnels will each be about 1140ft. long, 13ft. high, and 7ft. wide, and a saving of from £8000 to £10,000 in the cost of construction will be effected. The Railway and Canal Commission has now granted an amending Order, subject to an agreement being entered into with the Dover Harbour Board.

ASHCHURCH, the scene of the fatal accident of January 8th, is noteworthy in that two railways cross each other on the level at that place. The main line is the Bristol and Gloucester, and the intersecting is a connection between the Tewkesbury and Evesham branches. It was opened in 1864. Only one such crossing has been sanctioned by Parliament since, and that was the crossing of the Great Eastern Railway over the Peterborough, Wisbech and Lynn Railway at Murrow—opened in 1866. The crossing of what is now the Somerset and Dorset over the Bristol and Exeter at Highbridge, and that of the Midland, Bedford and Hitchin over the London and North-Western Bedford and Sandby branch were both opened in 1858. The Tramway Junction, Gloucester, where the Great Western Swindon and Gloucester crosses the Midland, Birmingham and Gloucester line was opened on May 12th, 1845, and is probably the oldest such crossing. That north of Darlington dates from October 2nd, 1848.

ACCORDING to the Board of Trade returns the value of the railway material sent overseas during the first eleven months of last year was as follows; the corresponding figures for 1927 and 1926 are added in brackets:—Locomotives, £3,203,773 (£2,053,870, £2,921,060); rails, £3,238,964 (£3,143,363, £1,331,633); carriages, £2,357,890 (£2,913,241, £2,538,142); wagons, £2,947,243 (£2,837,202, £2,638,990); wheels and axles, £696,215 (£772,276, £405,937); tires and axles, £547,515 (£663,221, £272,492); chairs and metal sleepers, £827,089 (£1,332,865, £636,558); miscellaneous permanent way, £1,227,485 (£1,378,499, £1,026,973); total permanent way, £6,658,944 (£7,531,456, £3,838,292). The weight of the rails exported was 371,836 tons (380,000 tons, 163,665 tons); and of the chairs and metal sleepers, 83,697 tons (134,786 tons, 65,481 tons). The value of the locomotives sent overseas during the month of November last was £271,241, and included:—India, £57,288; countries in South America other than the Argentine, £51,915; the Argentine, £31,520; British South Africa, £19,260; and Ceylon, £3106. During the same month the value of permanent way shipped was £3,333,946, and included:—The Argentine, £112,696; Portuguese East Africa, £47,018; India, £32,757; British West Africa, £7049; Australia, £5553; New Zealand, £2117.

Notes and Memoranda.

IT is announced from Ottawa that the Federal Government has concluded a contract with Professor Howard T. Barnes, of Montreal—inventor of the thermo-electrical process of melting great bodies of ice—to keep the St. Lawrence River channel clear this winter between Montreal and Sorel, and thus to advance the opening of navigation in the spring. The experiment, which is the largest of its kind yet undertaken, involves an expenditure of 60,000 dollars.

IN an article in the *Quarterly Report* issued by the Statistical Department of the Swedish Government, concerning the floating of timber down rivers, it is stated that it is naturally essential that the timber should float well. In the growing tree it is only the heartwood that is lighter than water: the log is thus kept afloat by its heartwood. This part of the log, moreover, absorbs water very slowly. It has been estimated that the proportion of the heartwood to the total volume must be at least 35 per cent. for satisfactory floating.

THE past year saw a great increase in commercial aviation in Canada. According to figures issued by the Department of National Defence, there are fifty-five commercial aviation companies in Canada, which is twice the number in operation a year ago; while, in addition, there are fifteen private owners and sixteen flying clubs. One of the companies during 1928 carried 9647 passengers and 1,192,000 lb. of goods. Besides transportation work, the companies are engaged in forestry and fisheries patrols, prospecting in the North, and grain dusting in the Western Provinces.

IN his comments on the failure of a small marine boiler, which had been mended by means of welding—it is not mentioned what process of welding was adopted—the Engineer Surveyor-in-Chief, Board of Trade, says that building up wasted plates by welding processes is a convenient and comparatively inexpensive method of repair, and for certain parts of boilers is quite suitable. It is not good practice and it may be very dangerous to adopt this method in the case of boiler shell plates which are wholly in tension. When such plates have been treated in this manner it is prudent to apply periodic hydraulic tests to not less than one and a-half times the working pressure after hammer-testing.

A REPORT from Stockholm states that a Swedish engineer, Carl Beskow, manager of Aktiebolaget Beskow, has invented a new radiator which, though its breadth is reduced by two-thirds as compared with ordinary radiators, has the same radiating surface, and which is claimed to be particularly suitable for small rooms. The radiator is not built up of small elements, but is composed of only two pressed plates, so that its construction represents a considerable saving of raw material and labour. The radiators can be galvanised or nickelled inside to keep them from rusting. The difficulty of enabling the plates to bear changes in pressure has been overcome by a special contrivance which is patented in all countries.

"As the vessel," a steam drifter, "sank, apparently as a consequence of the explosion, it has," writes the Engineer Surveyor-in-Chief, Board of Trade, "not been possible to ascertain the cause of the explosion or the part of the boiler which failed. But, from the engine driver's evidence, it appears to be very probable that some part of the boiler shell itself gave way. That a boiler could be in such a condition that this could happen is a serious matter, and was no doubt made possible by the fact that it had not been thoroughly examined by a competent person for some years. A more serious aspect of this case is the action of the Surveyor to the Underwriters who, without having made an inspection, signed a certificate which declared that 'hull and machinery was found to be in a perfectly seaworthy condition.'"

IN the Thomas Young Oration, given, before the Optical Society, Professor G. W. Ritchey said that optically polished surfaces of vitreous materials, such as glass, pyrex, and fused quartz have a liquid-like quality; their structure is so fine that it cannot be detected even with the highest power microscopes. When silvered by either the chemical or the cathode method, the silver film, deposited molecule by molecule on the polished vitreous surface, is so fine in structure that it takes the liquid-like quality of that surface. Further, the silver film is so thin, about 0·000004in., that it retains perfectly the optical figure (form) of the vitreous surface. Still further, its structure is so fine and dense that it is nearly opaque to the brightest light. These qualities, taken together, account for the very high reflective power of silvered vitreous surfaces when kept in fine condition. They account also for the fact that optically good mirrors with these surfaces permit the use of the full theoretical magnifying powers due to their apertures; these surfaces can therefore be regarded as real optical surfaces.

As the result of investigations previously carried out by the Safety in Mines Research Board, means have been devised to allow for complete or partial release of the pressure developed by firedamp explosion within closed vessels, such as the casings of electric switchgear, and at the same time to insure that the flame of the explosion shall not pass from the casing to the atmosphere outside. Experiments carried out by Beyling in Germany have, however, suggested that when the casings are divided into intercommunicating compartments by partitions, the ignition of an explosive mixture in one compartment might result in considerably enhanced pressure being produced in the other. An account of an investigation into this possibility is contained in a paper entitled "Firedamp Explosions Within Closed Vessels: 'Pressure Piling,'" by C. S. W. Grice and R. V. Wheeler (S.M.R.B. Paper No. 49, price 1s. net from H.M. Stationery Office). The research has shown that if an explosion of firedamp and air is allowed to propagate from a casing of comparatively large volume through a narrow opening into a casing of comparatively small volume, pressures considerably above the normal are very rapidly produced within the smaller casing, and that under these conditions even weak mixtures of firedamp and air can produce violent explosions. Care should, therefore, be exercised in the design of casings to avoid inter-connected compartments.

Miscellanea.

IT is said that Mr. Ford proposes to put up in Russia a factory capable of producing 100,000 motor cars a year.

ACCORDING to the *British-Russian Gazette*, a permanent exhibition of foreign machinery is being organised in Moscow.

IT has been decided by the Quebec Legislature that in cutting timber for the pulpwood trade, two trees must be planted for every one felled.

THE last unit of 65,000 horse-power at the Queenston power plant, Ontario, is to be supplied by the Canadian Westinghouse Company, at a cost of 5,000,000 dollars.

IT is proposed to utilise a waterfall in the Pei Lung Tan district of Honan, China. The head available is said to be 820ft., and the power which may be developed 2600 horse-power.

WHAT is described as the largest transaction in timber buying ever carried out has recently been completed by some Russian and British syndicates. It involves the transfer of 500,000 standards of timber valued at ten millions sterling.

AMONG the new factories to be put up in Ontario are one, to cost 500,000 dollars, for the Toronto Ironworks, and another for the National Steel Car Company, which will cover an area of 38 acres. The latter firm has, during the last six months, received orders to the value of 18,000,000 dollars.

A RETURN has been issued by the Ministry of Transport giving particulars of the number of mechanically propelled road vehicles for which licences were current at any time during the quarter ended September 30th, 1928. The total number of vehicles recorded was 2,052,453, compared with 1,899,650 during the corresponding period of 1927.

WORK on the Mandi electrification scheme is, according to *Indian Engineering*, proceeding rapidly. A large quantity of machinery has already been assembled at Shanan, where the material has been taken both by lorries and by the newly constructed Kangra Valley Railway. The operations are so advanced that the second stage of construction, namely, the building of a dam across the Uhl River to increase the generation to over 70,000 kilowatts, has now begun to approach completion. The erection of a transmission system is expected to start about six months hence, though a longer period will have to elapse before the actual supply of electric power begins.

IT is understood that the Committee, presided over by Sir Arthur Balfour, appointed by the Labour Government in 1924 to inquire into the condition of industry and trade in Great Britain, has now signed its final report. The Committee has already issued several interim reports covering various sections of industry, and in the final report, so we gather, makes certain recommendations which it has arrived at as a result of considering the position as a whole. The final report, it is understood, is not unanimous, the five labour members of the Committee signing a minority report. It is rumoured that the majority report favours a measure of safeguarding for the iron and steel industry.

THE Northern Power Company, a subsidiary of the Winnipeg Electric Company, has decided to proceed immediately with the development of its power site at Seven Sister Falls on the Winnipeg River in Manitoba. The sum of 15,000,000 dollars has been appropriated for the work, and the Carter-Halls Aldinger Company, of Winnipeg, has received the order for the construction of the concrete dams, spillways and sluices, together with the concrete foundations and structures for the power-houses. The initial capacity of the development, when operating on full head, will be 112000 horse-power. It is expected that the city of Winnipeg will be receiving power from this source towards the end of 1930. The ultimate capacity will be 225,000 horse-power.

THE amount of water which Ontario is allowed to divert from the Niagara River for hydro-electric development will be increased by 10,000 cubic feet per second under a treaty signed at Ottawa by Premier MacKenzie King on behalf of Canada, and Honourable William Phillips, United States Minister for Canada, subject to ratification by both Governments. The treaty also provides for extensive remedial work to preserve the scenic beauty of the Horseshoe Falls and the cataract generally, the cost of which is estimated at 1,750,000 dollars. This expenditure will be shared by the Ontario Hydro-electric Power Commission and the Niagara Falls Power Company, of Niagara Falls, N.Y., on condition that they are permitted to use in their plants at the Falls an additional 10,000 cubic feet per second each during the winter season commencing October and ending March 31st for a period of seven years from the date of the initial diversion authorised. No new plants will be constructed, but all the additional water diverted will be used in the existing plants, the additional extraction bringing the total volume of water which Ontario is entitled to divert up to 46,000 cubic feet per second.

AN unfortunate accident recently took place in the Metropolitan-Vickers Trafford Park Works to a large frequency changer. Whilst it was running at full speed on test, a short circuit in the pit under the machine set fire to a temporary wooden air discharge duct. Flames drawn in from the duct by fans at both ends of the machine then set fire to the stator windings, which were seriously damaged in the period of five minutes that elapsed before the rotor, weighing over 70 tons, could be brought to rest. On inspecting the damage, it was decided completely to rebuild the stator, using new laminations, new copper, and new insulation throughout, and although the work is being pushed forward strenuously by everyone concerned, it is estimated that a delay of seven weeks may occur. The set is notable as being easily the largest frequency changer yet built in this country. It is a reversible machine designed on the one side for 3-phase, 25-periods, 11,000 volts, and on the other side for 3-phase, 50-periods, 6600 volts. The normal rating is 33,000 kVA at 500 r.p.m., with a momentary overload capacity of 100 per cent. The set is being built to the order of the London Power Company for the Deptford West Station.

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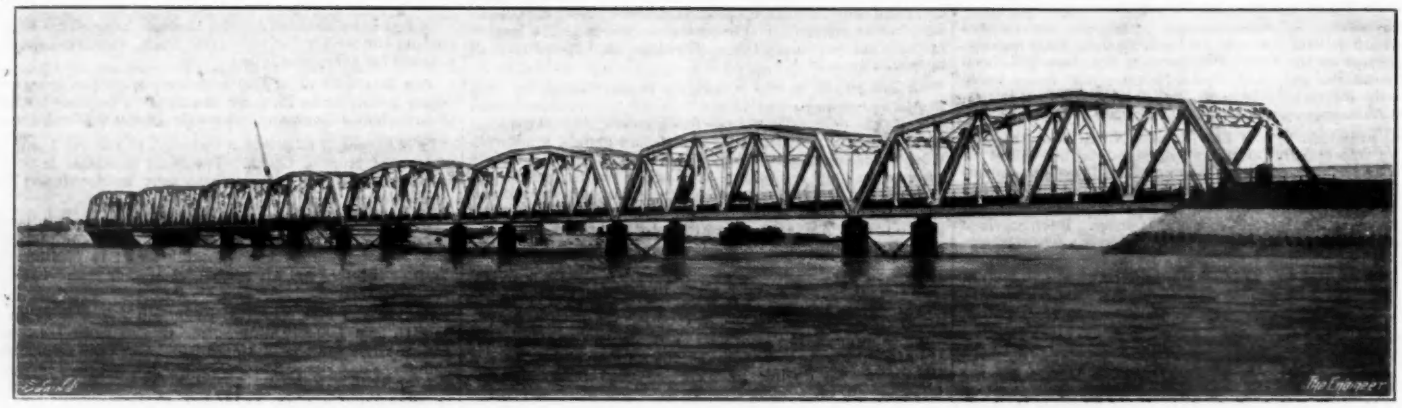
(*For description see page* 124)



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THE ENGINEER.

FEBRUARY 1, 1929.

The Channel Tunnel.

CHANNEL TUNNEL projects are even older than railways. They have cropped up periodically since the early years of last century. Zerah Colburn was the father of one. He proposed that a tube with spherical joints should be sunk to the bottom of the sea, and as he was for a few years editor of this paper, we may lay claim to a special interest in such schemes. Needless to say, we have always, as engineers, desired to see the tunnel constructed, and regretted that whenever Parliament has given consideration to the project the military authorities have caused the necessary sanction to be refused. In a matter of this kind history repeats itself, and one has only to read the numerous letters which have appeared recently in the Press to see that soldiers are just as fearful as ever that the tunnel would open a joint in the armour of our little island. The civilian may be forgiven for supposing that conditions have so changed since the war that such an argument now carries little weight. The coming of the aeroplane, alone, has almost robbed us of the defence which the "narrow seas" once were. But the opinion of the military authorities on a matter so technical must be paramount, and we can only hope that when the inquiry which Mr. Baldwin has promised is opened the strength of their opposition to the scheme will be closely in accord with probabilities and will not be founded on an anxiety which, however justifiable on military principles, may delay the development of economic relationships between Great Britain and the Continent of Europe.

To our minds more important questions even than that of the country's safety from invasion are, on the one hand, the economic value of the tunnel, and, on the other, the engineering problems associated with its construction. It must not be too lightly assumed that there is no doubt about either. The advantages that might accrue from direct railway communication between the Continent and Great Britain is obvious. But it is not yet proved beyond contention that the tunnel can be constructed and maintained at a cost that would put such advantages on an economic basis. If there were no other means of communication, then no reasonable expense upon the tunnel would be excessive. But, neglecting the certain development of aerial transport, there already exists a great maritime trade for which special harbours with their costly equipment have been provided. In estimating the financial prosperity of the tunnel we must make proper allowances for the diminution in the prosperity of the ships and harbours, unless it should happen that the tunnel made its own trade without taking aught from that which exists. That is extremely improbable. The improved facilities for intercourse which it would offer would no doubt attract more passengers, and the reduction in freight charges and increase in expedition would encourage the extension of trade; but it is hardly conceivable that the cross-Channel services or the freight services which are now conducted by ships would retain their present magnitude. We do not advance these considerations in opposition to the construction of the tunnel, but only to indicate the difficulties of the economic questions. The better is always the enemy of the good, and fine as our cross-Channel systems are, they will have to go if something better is there to take their place. The desirability of uninterrupted railway communication between Great Britain, which is still the business centre of the world, and the furthest parts of the Continent cannot be doubted; but we must warn the public against the easy belief into which it appears to be falling that the economic questions associated with the building of a tunnel are readily settled. The technical problems are equally great. We have had in the past the assurance of civil engineers that the tunnel can be constructed, and we have as little doubt that it can be built as that it will be built. But no one dare say that it will be an easy task, and that serious obstacles and difficulties will not be encountered. The intended means of construction presupposes an influx of water no greater than can be dealt with by a pumping system of reasonable size. If it should happen that a serious fault were encountered in the bed of the Channel then entirely new methods of continuing the construction would have to be found. We believe we are right in saying that at the present time there is no experience in sub-aqueous tunnelling at a depth far greater than that at which compressed air could be used. So great is the ability of engineers in the overcoming of obstacles that even such a mighty problem as that would, we are sure, be solved in time, but at what cost we know not.

We have indicated in the merest outline the kind of difficulties that have to be encountered in the construction and operation of a tunnel. We have done so not because we have any hesitation about advocating the prosecution of the work, but solely because we have noticed in the discussion of the project an easy confidence that it is all plain sailing and that no one save an obstinate Government, scared by the fears of its military advisers, would hesitate for a moment to sanction the undertaking. That is very far from the real facts. Even the military objections must carry some weight, and there are economic problems of the first order to be considered. Then when all those obstacles are cleared away there will remain technical problems, the magnitude of which can be only surmised. Taken for all in all the Channel Tunnel, when it is constructed—as it will be—will be one of the most stupendous of the marvellous works of civil engineers.

The "Grid" Transmission System.

AT a meeting held last week at the headquarters of the Institution of Electrical Engineers many interesting technical points concerning the construction of the grid transmission system in Great Britain were dealt with in a paper by Messrs. Johnstone Wright and C. W. Marshall, of the Central Electricity Board. Judging by the large attendance the "grid" is creating a considerable amount of interest, but although representatives of many branches of the electrical industry were present, the paper failed to produce a lively discussion. No one seemed to have very much fault to find with the authors' technical suggestions or with the scheme as a whole. In view of the wide and varied field covered and the diversity of opinion that exists concerning certain transmission problems, the lack of real criticism was quite surprising. The methods of protecting lines against the abnormal increases of potential which may occur owing to lightning and abrupt changes of load is one of many matters that might have been discussed, but, as it was, very little of a critical nature was said. Nevertheless as an outline of the chief

constructional features of the system of high-voltage transmission lines which are being constructed under the provisions of the 1926 Electricity Act, the paper is to be regarded as a contribution of considerable value. Nothing is more desirable at the present time than a clear understanding of the lines upon which the "grid" transmission system is to be constructed. Manufacturers who are hoping to take part in the work should appreciate the paper because it throws considerable light upon the type of equipment that is likely to be called for. In some respects the second part, which gives some of the essential features of the actual construction of the grid, so as to illustrate the general principles outlined in the first part, published in abstract on another page, is the most interesting. Particulars are here given of the work being carried out in Central Scotland, involving the interconnection of thirteen supply stations situated in three main districts and necessitating overhead line work with divergences from standard practice at the crossings of the rivers Cart, Clyde and Forth.

The "grid" has naturally set electrical manufacturers new problems, as, for example, in connection with the design of large transformers and switchgear. The great power capacities of the various sections of the "grid" will give rise to very high short-circuit currents and mechanical stresses in transformer windings, and to meet these conditions the transformers are given a high impedance and are very strongly supported and constructed. Another problem with which manufacturers have had to grapple is that of regulating the voltage of large transformers whilst they are carrying load. Apparently there are no restrictions on manufacturers regarding the methods whereby the regulation is carried out, other than the requirements that no phase displacement shall be produced, but all the large transformer makers seem to be concentrating their attention on the system of tap changing under load. The first firm to produce large 132-kV transformers fitted with this gear was Ferranti, Ltd. Other firms are now producing "grid" transformers that are regulated in this way, and from the points of view of simplicity and cheapness the scheme appears to be preferable to certain others. All the transformers for the 132-kV system are designed for outdoor working with the high-tension windings star connected and with the neutral point permanently and directly connected to earth. The switchgear associated with the grid will naturally constitute an important and expensive part of the equipment. For the Central Scotland scheme alone the switchgear for thirteen outdoor sub-stations will cost £316,420. Researches that are now being undertaken in connection with circuit breaking, however, are said to be bringing new and interesting facts to light, and it is within the range of possibility that before the grid is completed something more simple and less costly will be available. Many feel that in these days of rapid progress a fair amount of the grid equipment will be out of date before the long-promised cheap supplies arrive.

One of the most difficult tasks that remains to be dealt with in certain areas is that of standardising frequency, which, needless to say, scarcely comes within the scope of Messrs. Wright and Marshall's paper on the construction of the grid. The problem, however, remains. Precisely what progress is being made in this direction we do not know, and it is to be hoped that before long someone will read a paper describing how this troublesome job is being tackled. If a standard frequency existed throughout Great Britain the work of carrying out the Government's scheme would be simplified. In this respect certain other countries that are constructing grid transmission systems stand at considerable advantage, for the frequency is already uniform. Reports that reach us from time to time indicate that one of the effects of interconnection up to the present has been to create a demand for frequency changers, which, in our opinion, are distinctly undesirable. The establishment of a uniform frequency throughout Great Britain is an item in the Government's programme that has always interested us, for upon it the attainment of a simple and straightforward system of interconnection depends. There is still, we fear, much to be discovered before the grid is complete, and it may easily happen that in some respects original ideas will have to be modified.

British Agricultural Machinery in France.

ONE result of the economic changes after the war was the creation in France of an important agricultural engineering industry, and British firms, which had found a valuable market in that country, were shut out by a wall of tariffs that was raised for the protection of home manufacturers. United States and Canadian firms escaped the burden of tariffs and freights by laying down large factories in France. The home production is now sufficient to supply practically all requirements. At the same time, efforts have been made to concentrate, as far as possible, the continental trade in implements and machinery by organising the annual Salon de la Machine Agricole in Paris. At one period it seemed as if the Ministry of Agriculture would succeed in this attempt, but the show held recently pointed to changes which may possibly adjust trade in a way to give some advantage to British makers, at least in certain classes of machines. There can be no doubt that the Paris Show is of real value as a means of reaching not only French users, but also agriculturists in other countries who have come to regard it as one of the most comprehensive manifestations of the agricultural engineering industry. There are exhibitors from Germany, Italy, Belgium, Hungary, Czecho-Slovakia, as well as from England, and this international character of the Show tends to disprove the claims of the French that they have now secured a monopoly of their own market. So long as they were favoured by a monetary depreciation the cost of imported machinery was so high that there was obviously no hope of supplying the demand at normal prices, except by manufacturing in the country. Since then the situation has been modified by the dissatisfaction of users of certain classes of French machinery, such as grass mowers, harvesting machinery and finishing thrashing machines, and in many cases old customers are coming back with inquiries for British productions which have maintained their reputation for quality and reliability. The only thing that stands in the way of a much larger business is the price. French agents are glad to handle British agricultural machines because they invariably give satisfaction, but in most cases the margin of price, as compared with the cost of machines manufactured in France, is still too high to allow of business being done, although users will pay more within reason for certain British machines. High import duties and freights add to the problem, but it is not insoluble, as is proved by the success of some English makers of grass mowers, grist mills, oil engines and certain other machines who have done quite well in the French market, although it is possible that they may have had to make sacrifices in order to keep the trade. It seems fairly certain that it is to the interest of British firms to consent to such sacrifices, for in keeping their hold on the French market they are helping their continental trade generally, and there is meanwhile a narrowing down of the margin of production costs in the two countries which may eventually facilitate the efforts of British makers to extend their business.

There is no doubt that costs are rising in France. Everything tends in time to bring those costs to the world level imposed by the gold standard. Protective tariffs are, of course, always a menace to foreign firms endeavouring to do business in France, but there is a limit to those tariffs, and farmers will never consent to a fiscal system which will increase unduly the price they pay for machinery. Therefore the present situation may be regarded as one of transition, during which the French agricultural engineering industry is being built up by artificial stimulants. It is a permanent and growing industry and has had infused into it a great element of vitality by the creation in France of huge factories by American manufacturers, whose products are really French, although they are classed by French manufacturers as foreign, but a readjustment of values should nevertheless enable British makers in the future to improve their standing in the French market and thereby increase their business elsewhere on the Continent. Not for many years had English tillage implements been exhibited in Paris. Yet at the last Show one of the leading English agricultural engineering firms exhibited implements with the object of ascertaining how such participation would help its foreign trade.

Literature.

SHORT NOTICES.

Alfred Schlomann's Illustrated Technical Dictionaries in Six Languages." Volume II., Electrical Engineering and Electrochemistry. Revised edition, with 3965 illustrations. Distributors for Great Britain and the British Empire: Lewenz and Wilkinson, Ltd., 25, Victoria-street, London, S.W. 1. Price £4.—This work, which is copyright by the Technische Wörterbücher-Verlag G.m.b.H., Beuthstr 8, Berlin, S.W. 19, may well be termed monumental. The main body of it—the classified section—runs to some 800 pages, and the index in six languages—German, English, Russian, French, Italian and Spanish—accounts for another 500 pages. The task of rewriting it has taken nine years, and in the rewriting all the sections have been enlarged, while two new sections—Electrical Jurisprudence and Electrical Economics—have been added. It is explained in the introduction that in the preparation of the volume no word has been taken from the first edition without careful scrutiny, and it is claimed that it is really a new work from cover to cover, since there have been so many changes in technical nomenclature during the last twenty years that more than mere revision was necessary. This claim would appear to be amply justified; at any rate, the book is bigger and more elaborate in every way. So far as we have tested it, we have found it accurate in all particulars, while the reciprocal phraseology appears to be, in most cases, excellent. The only criticism that we have to make is that less space is devoted to wireless telegraphy and telephony than we should have expected, having regard to the enormous strides made in that direction during recent years. In the preparation of the work, German, British, Russian, French, Italian and Spanish electrical engineers and technicians of high standing have collaborated. Among those in this country who are specially mentioned as having rendered valuable assistance are:—Dr. Ernest Fyleman, Dr. H. S. Hatfield, Mr. H. I. Lewenz, Mr. H. Minas, Dr. W. H. Patterson, Mr. G. N. Rocky, Mr. Victor Sinclair, Dr. Stanley Parker Smith, and Dr. J. W. T. Walsh. The cost of preparing the dictionary, which is said to have been in the neighbourhood of half a million gold marks, or, say, £25,000, has been provided by the German Government, the big German Scientific and Engineering Societies, and the "Notgemeinschaft der Deutschen Wissenschaft"—Society for the Support of German Science.

The Installation of Electric Lighting and Heating. By Frederic H. Taylor. Chapman and Hall, Ltd., 11, Henrietta-street, Covent Garden, W.C. 2. Price 7s. 6d.—Much of interest to those engaged upon electric lighting and heating work is to be found in this book, which is written on thoroughly practical lines. Special attention has been paid to the details of workmanship as well as to the essential points in the accessories and materials used, and in view of the growing importance and the probability of further regulations in the near future, the necessity for efficient earthing and the proper testing thereof has been specially emphasised. The early part of the book covers such things as V.I.R. conductors, paper-insulated, and aerial conductors. Attention is paid to conductor current density and voltage drop, systems of wiring, the wiring of special positions, conduits and their wiring. There are also chapters on lamp holders, ceiling roses, lamp switches, plugs, fuses, and distribution boards, main fuses and switches, the testing of a completed installation, the planning of a lighting installation and electric heating and cooking. For the sake of completeness, Tables I. to VIII. of the regulations of the Institution of Electrical Engineers are included in an appendix, and many extracts from these regulations are given to amplify the text.

Distribution of Electricity by Overhead Lines. By William T. Taylor. London: Charles Griffin and Co., Ltd. Price 25s.—The rapidly increasing use of overhead lines in this country has naturally encouraged those with knowledge of the subject to produce books on overhead transmission and distribution, and within recent times quite an appreciable amount of literature of this nature has come to our notice. The present volume is intended for engineers and others engaged in the planning, construction and operation of overhead distribution lines. The practical methods of design, construction and operation are discussed and a novel line distribution system is proposed. The book is devoid of descriptive matter, such as that to be found in manufacturers' catalogues. The practice presented applies to all countries, but a considerable number of tables based on American practice are included. In the early part of the book the author discusses distribution systems and their development, aspects of location and design of distribution lines, calculations for the design of lines, and aspects of distribution line construction. Other chapters deal with the distribution system and aspects of distribution maintenance. The author's experience in overhead line work appears to extend over many years, and the volume has the advantage of being written on thoroughly practical lines. Engineers and others engaged in the planning, construction and operation of overhead distribution systems should find the volume useful.

Dielectric Phenomena: Electrical Discharges in Liquids. By S. Whitehead. London: Ernest Benn, Ltd. Price 12s. 6d.—This volume is the second of a series prepared by the Electrical Research Association, giving a critical *résumé* of available information on dielectric phenomena, with particular attention to the theoretical basis and particular reference to the failure of insulation in service. The present volume deals with discharge phenomena in liquids. Experimental evidence and empirical data are followed by a discussion of the theories which have been put forward and which are considered in the light of the facts detailed in the earlier part of the book. Reference is found in various parts of the volume to work done by the Electrical Research Association, and in the Preface appreciation is expressed of the work carried out on its behalf by several investigators, particularly Mr. J. T. Cogle, of the Metroploitan-Vickers Research Laboratories, and Mr. A. N. Jackson, at University College, London, for extensive investigations into insulating oils, and Mr. W. R. Plumby, at the City and Guilds Technical College, for investigation of the phenomenon of corona in oil.

An Introduction to the Theory of Eddy Current Heating. By C. R. Burch and N. Ryland Davis. With an introduction by A. P. M. Fleming. London: Ernest Benn, Ltd. Price 12s. 6d.—With the rapidly increasing use of induction furnaces, this book comes at an opportune time, and will in all probability meet with much appreciation, but it is not a book of a simple kind which can be understood

by people devoid of mathematical knowledge. The first few pages on the principle of the induction furnace will present no difficulty to practical men, but when the authors proceed to discuss the mathematical theory, the work becomes more involved. For the most part the book is, as the title indicates, devoted to theory, which is not quite so simple as many may have supposed. From the point of view of research workers and designers, however, the volume would appear to have much to recommend it. Although there are only 71 pages, the theory of eddy current heating is pretty well covered.

Alkaline Accumulators. By J. T. Grennell and F. M. Lea. London: Longmans, Green and Co. Price 10s. 6d.—While there is no shortage of literature on storage batteries, this is the first volume that has come to our notice that deals exclusively with alkaline batteries. The authors' aim is to give a general account of these accumulators, and to emphasise those characteristics in which they differ from lead cells. Their advantages and disadvantages are described, and the various fields in which they excel are indicated. A fair balance between theory and practice has been preserved. Considerable emphasis is laid on the general principles of the working of accumulators and on the factors affecting their operation, but with the exception of one chapter on cell reactions, the text has been kept as non-specialised as possible.

Telephone Progress in the London Area.

DURING 1928 continued progress was made in the London telephone service. New exchanges were opened for service, and increased traffic and revenue were recorded. A notable advance was also made in the conversion of the 10-mile circle to automatic working. Six additional automatic exchanges with a capacity of 37,150 lines were opened during the year, and they are said to be giving satisfactory service. International telephonic communication by cable and wireless was greatly developed. London is now connected by cable to most of the countries in West, South and Central Europe, whilst the Transatlantic telephone service, *viâ* London, was made available to the chief cities in those countries. On the other side of the Atlantic, the service was extended to all parts of Canada, and to Mexico. A second radio channel was opened, and the hours of service were extended to meet the increasing demand for calls.

The increase during the past year brought the number of exchanges in the London area to a total of 130, viz., 119 manual exchanges, seven automatic exchanges, two toll exchanges, one trunk exchange, and the tandem exchange. The number of exchange lines at the end of 1928 was 355,983, the increase for the year being 28,940, or about 8·8 per cent. In addition to the exchange lines there were at the end of the year 15,590 private lines. The total number of telephones—exchange and private—at the end of 1928 was 614,183, an increase over the previous year of 48,593, or 8·6 per cent. Over 26,000 private branch exchanges are now in use in the London area. Of this number, 25,920 are manually operated and 124 are automatic. Two private branch exchanges of exceptional size were provided during the year. The first, which was installed at a large departmental stores, is equipped with 500 extension lines, 129 exchange lines, and 15 operating positions for the receipt of incoming traffic. Facilities are provided whereby the extension users are able to dial in directly to the public system without the intervention of the private branch exchange operator.

The second was installed to serve a large suite of offices, and consists of a multiple lamp signalling switchboard of 15 positions, on which 50 exchange lines and 1000 extension lines are accommodated. The number of call offices working at the end of 1928 was 5512, the increase for the year being 436. The provision of pre-payment multi-coin boxes in call offices was considerably extended. About 2850 of these boxes have already been fitted in the London area, and the number will be largely increased during the present year. The advantage of this type of box is that callers can pass trunk and toll calls and telegrams at any time of the day and night. Multi-coin boxes fitted with dials will be provided at all call offices connected to automatic exchanges. Such boxes have already been installed in the Bermondsey exchange area, and also at certain call offices connected to the Bishopsgate exchange. A local fee call can be made by inserting the proper fee and dialling the exchange code and number of the required subscriber. For other calls, *i.e.*, for trunks, toll and telegrams, or if a telephonist is required for any purpose, the caller first dials "O" and subsequently inserts the appropriate fee after receiving from the telephonist an intimation of the sum required.

The number of kiosks erected during the year was 459, the total now being 1214. The conversion from manual to automatic working within the inner London area is proceeding. During the past year six additional automatic exchanges were opened, viz., Bishopsgate, Sloane, Bermondsey, Monument, Mansion House, and Welbeck. Bishopsgate, Monument and Mansion House exchanges provide additional equipment in the City area, while Sloane and Welbeck serve the districts in the neighbourhood of Sloane-square and Harley-street respectively. These exchanges have an equipped capacity of 37,200 lines.

During 1928 the number of additional junction circuits provided between exchanges was approximately 4000. This figure includes circuits required for new exchanges as well as circuits required to carry the increase in traffic between exchanges already in service. The rearrangement of the junction cables following upon the opening of the tandem and toll exchanges, and the consequent alteration in the routing of traffic between the various exchanges, is progressing satisfactorily. There are now approximately 40,000 junction circuits, and the mileage of conductors in the cables provided for junction service is approximately 350,000 miles. The total mileage of single wire provided for subscribers' lines and local junctions is 2,672,977, an increase during the year of 283,839 miles. There is an increase of 827 miles of conduit, the total now being 10,260 miles. The length of open wire in London is 56,239 miles, carried on 5795 miles of pole line.

Mention should be made of the fire which broke out in the Thames Embankment subway in the early part of September, which resulted in the destruction of 53 of the Department's cables, carrying approximately 200 main trunk and telegraph circuits, 3000 junction circuits, and 2500 subscribers' and local circuits. Upwards of twenty of the Department's cables also suffered severely as a result of an explosion which took place in High-street, Holborn, at the end of December. Telephone service between a large number of exchanges was interrupted, but a partial service was given in a few hours. The work of establishing alternative routes was put in hand at once, and within a week practically full service was restored.

Owing to the expansion of the telephone service, it is necessary continuously to extend the amount of underground and overhead plant. Efforts are made to estimate hte requirements for a number of years, so that successive openings of the same route may be avoided. Co-operation is also effected with the various roadway authorities, with a view to placing the Department's plant in position before paving works are carried out. Generally it is found that the authorities are helpful, and the Department's relations with them continue to be satisfactory.

A new trunk cable from London to Uxbridge was completed and brought into use. This cable has been connected to an existing Uxbridge–Oxford cable, thus providing improved service between London and Oxford district, as well as providing additional circuits from London to the rapidly developing Uxbridge neighbourhood. A new cable from London to Sunbury, Feltham, Ashford, Staines, Egham, Ascot, Bracknell, Bagshot, and Camberley was also completed and brought into use, and the following cables have been extended:—London–Canterbury, extended to Dover and Folkestone; London–Uckfield, extended to Lewes, Brighton, Newhaven, Seaford, and Eastbourne; and London–Maidenhead, extended to Henley-on-Thames.

Some Aspects of Permanent Way Maintenance in Japan.

SPEAKING at the annual winter meeting of the Permanent Way Institution on January 26th, Mr. Tamiya Nagata said that the honour which had been done him by his election as a Fellow was something more than a personal one. It was already regarded by his London colleagues, and would be regarded by his colleagues in Japan, as an honour to Japanese railwaymen, and would add another link to the bonds of cordial relationship and friendship which had so long existed between the railwaymen of the two Island Empires of the East and West.

Mr. Nagata then read a paper, entitled "Some Aspects of Permanent Way Maintenance in Japan," from which we make a few excerpts.

It is interesting to note that Japan owes the construction of her first railway to a British engineer, Mr. Edmond Morel, who was chief construction engineer of a short line of 18 miles between Tokyo and Yokohama. This line was opened in 1872, and in the fifty-six years which have elapsed since that auspicious occasion the Japanese railways have made wonderful progress, the mileage having been added to year by year. At the end of last March, which is the end of our fiscal year, the total mileage was 8322 miles, and every year about 300 miles are added. There are 687 miles now under construction, and preparations are being made for the construction of 2126 miles, which have been sanctioned by Parliament. The gauge of all the Japanese lines is 3ft. 6in.

Owing to the topography of Japan being exceedingly complex and mountainous in character, there are many sharp curves and steep gradients. In fact, nearly 30 per cent. of the mileage is on curves of various radii, and more than 30 per cent. is on gradients steeper than 1 in 100, whilst long sections of 1 in 60 and even 1 in 40 are not rare. In recent years, however, the regulations have stipulated the minimum radius of curvature to be 15 chains, while all gradients have been avoided as far as possible.

The maximum axle load of locomotives which run on our lines is limited to 14·763 tons, as against 17·715 tons on special lines. The average weight of the larger locomotives in service on the main lines is now well over 120 tons, but owing to the narrow gauge and the prevalence of sharp curves and steep gradients, the running speed of the trains is under 50 miles per hour.

Rails.—The rails in use are mostly 60 lb., 75 lb., and 100 lb. per yard, all the last-named being flat-bottomed. With regard to the type of rails, in the 60 lb. and 75 lb. rails, there are many of the A.S.C.E. type, whilst rails of the old British standard type are also well in evidence. The 100 lb. rails are the Pennsylvania section type.

The standard length of our rails has been 33ft. for many years, but recently we commenced experimenting with 39ft. for the 100 lb. rails. For more than twenty years we have been gradually using home-made rails, and nearly half the rails now laid down are home-made. But, even now, we cannot say that the importing of rails from Great Britain, the Continent, and America has ceased.

The quality of the steel of our rails is the ordinary carbon steel of basic or acid converter and open hearth, and mostly contains carbon from 0·22 to 0·51 per cent. We are now also experimenting with sorbitic rails and British-made alloy steel rails.

Sleepers.—With the exception of steel sleepers used in the Abt rack section in our most mountainous region, our sleepers are mostly of timber, 8in. wide, 5½in. thick, and 7ft. long. The number usually used for the 33ft. rail is fourteen or fifteen on the main lines and thirteen on the sidings. The timber is mostly chestnut, but pine, shii (*Pasania cuspidatea*), and nara (a kind of oak, *Quercus glandulifera*), are also used. Formerly all were untreated, but during the last fifteen years creosoted sleepers have been interspersed. The sleepers for bridges, points and crossings are of special sizes, and the timber used is mostly hinoki and hiba (a kind of cypress). All these sleepers are of home-grown timber, but besides these we are experimenting with metallic sleepers, reinforced concrete sleepers, and also utilising scrap rails to produce sleepers. Although our sleepers are now mainly of timber, our supply is limited, and it is strongly felt that, as our mileage increases, we shall inevitably have to use metallic sleepers, and investigation and research on this point are now being strenuously carried on.

Road Bed.—The usual breadth of the road bed is 16ft., and, except in special cases, the bed is the natural soil untouched. In special cases, in the districts of severe cold, rubbles are used to prevent the upheaval of the soil by frost.

Bridges.—The total number of bridges is 26,314, and their aggregate length is 240 miles, which corresponds to 2·9 per cent. of the total length of the open lines. Owing to topographical conditions of our country, very long span bridges are very rare. The longest bridge is 4077ft., and the longest truss is 300ft. Formerly all the girders were imported, but of late the girders are mostly of home-made materials, and they are almost wholly made in the home workshops.

ORGANISATION OF PERMANENT WAY WORK.

Under the Minister of Railways at Tokyo, the Ministry is divided into several bureaux. The total area of the railways is divided into six regions, which roughly correspond to the four great railway companies in this country. Each of the regions has its own head office in the principal town of the region, and is under the control of a director.

The permanent way is controlled by the Ministry through the Bureau of Maintenance and Improvement, which has four Departments, viz., Maintenance, Planning, Improvement, and Building. The Bureau has charge of the design and execution of the permanent way work, the preparation of materials, and also the various investigations and experiments. The actual work of the permanent way, however, is executed under the control of the director of each region. Each region has a Maintenance Section, which has charge of the planning, design and adjustment of the permanent way work within its area. Distributed throughout the six regions there are thirty-eight division maintenance offices, which act in conjunction with the division traffic offices, each controlling about 200 miles on an average. Under these division maintenance offices there are maintenance section offices, each of which controls about 50 miles on an average, and also has charge of the inspection and repair of tracks and buildings.

Under the chief of each maintenance section office there are two assistant chiefs—one for maintenance and the other for construction. These maintenance section offices are subdivided into sub-sections of about 10 miles each, under a resident superintendent in charge of each sub-section. They are responsible for the distribution, control, and encouragement of the daily maintenance work. Under them, the lines are portioned, in stretches of about 3½ miles each, to a ganger and his gang and they devote themselves entirely to maintenance.

Besides the above, there is generally attached to each sub-section an assistant superintendent, who has the special duty of inspecting the track, noting the manner of working and the diligence and slackness of the gangs, inspecting the bridge guards and level crossing guards, and sometimes in important work even leading the gangers and their gangs.

At the end of the last fiscal year, March 31st, 1928, the total number of permanent way men was 28,139, and their aggregate salaries and wages amounted to £1,749,853, which corresponds to about 37 per cent. of the total permanent way maintenance expenditure for the year of £4,771,476. More than 60 per cent. of this sum went for the maintenance of the track alone, viz., £3,023,687. The average maintenance expense per mile of track on the main lines last year was £310.

The phenomenal increase in traffic, which recently doubled itself within ten years, necessitated heavier and more powerful engines, but there were many tunnels and bridges not suited for such heavy traffic. It was therefore resolved to improve these structures to meet all possible requirements. Although this work was tackled with all our power, it was found necessary in very many cases to reinforce temporarily structures to allow the traffic to proceed. This rebuilding is one of the big features of our work.

Similarly with the rails, their fatigue is so tremendous that we are forced to change to heavier rails, and this work is also proceeding according to our annual plan. In connection with this, much research and investigation is being done to find the right quality suited to the climatic conditions and train operation of our country. So far we have adopted nearly the same quality as specified in the British standard specification.

River Pebble Drags.—Owing to the number of accidents which occurred through trains over-running the buffer stops, experiments were set on foot to devise some safer plan. It was finally decided to adopt, as the standard, a system which we call "River Pebble Drags," somewhat resembling sand tracks in operation without rails. The length of these drags is 131ft. 3in., 98ft. 5in., and 65ft. 7in., depending upon the approaching gradients. In ordinary cases, the thickness of the pebble drag is 9¾in., both upon and below rail level; that is, the total thickness is 19½in. In other cases, where it is considered to be inconvenient to bank the pebbles above rail level, the thickness of 19½in. of pebbles is placed only under rail level. In one instance, for example, a train composed of an engine and thirty-nine cars ran into a river pebble drag, banked to a height of 15¾in., at a speed of 34·4 miles per hour, with the result that the leading wheel of the engine stopped at a distance of 95ft. 2in. from the beginning of the drag within 3⅛ sec.

The Human Element.—The best example of the efficiency of the human element on Japanese railways comes from the Great Earthquake in 1923. Faced with such a big emergency as the death of over 100,000 people, with every communication from or to Tokyo entirely stopped, with 179 miles of track totally destroyed, and many bridges and tunnels collapsed, from every region there hurried engineers and permanent way men, over land, on foot or by sea, to the devastated sites, and without sufficient food and with scarcely any sleep or rest, they tackled their big job of repair with such skill and energy that within twenty-one days the most important trunk line was again fully opened.

IT is estimated that the completion of the Canton–Hankow railway, China, will cost about six and a half millions sterling.

Tendencies in Steam Turbine Development.*

By H. L. GUY.

THE art of generating and distributing electric power is advancing so rapidly that many questions arise demanding immediate decision in advance of the guidance which experience and exhaustive trial can give. It is desirable in such matters that those of varied knowledge, experience and opinions, those who use plant as well as those who supply it, shall meet periodically in a community of deliberation. In providing a vehicle to facilitate such discussion on matters on which opinion is still in process of formation, the Institution discharges one of its prime functions.

To assist in visualising some of the more obvious directions in which development is taking place, certain main characteristics of steam plant for electrical generation have been plotted in Fig. 1, from the statistics of orders received by the works with which the author is associated.

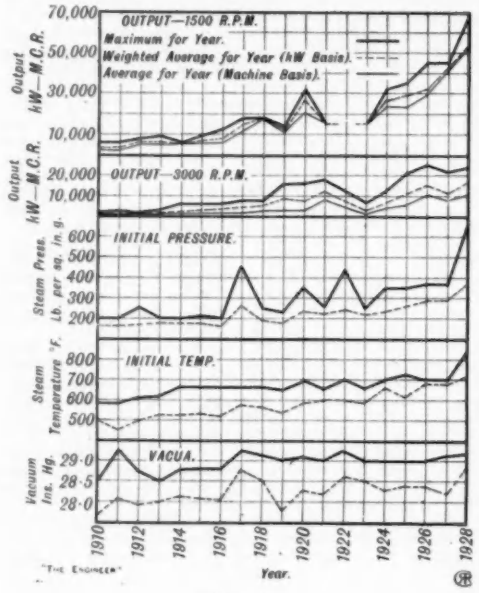


FIG. 1

Averages are expressed on a basis of capacity and not of separate machines. In the period of eighteen years which is under review, the average capacity of machines running at 3000 r.p.m has increased about twelve times from 850 to 10,000 kW. The slightly larger ratio of increase in size of the 1500 r.p.m. machines—which is nearly fifteen times—is a result of the continuous tendency at all times to employ 1500 r.p.m. for those ratings only which cannot be satisfactorily constructed at 3000 r.p.m., and of the relatively decreasing market employing 25 periods.

Average pressures have been doubled, while the maximum has increased over three times. The curve of average pressures betrays the characteristic of successive phases of increasing and constant levels, with the level changing at the present time. Temperatures, as with pressures, have been increasing in successive steps. There is some evidence that we are entering upon another period of increase. Maximum vacua have not changed in level throughout the entire period. Average vacua on the whole show a slight but steady increase, resulting from the increasing tendency to take large power stations to sites providing ample circulating water.

Of the tendencies affecting the thermal efficiency of power plant, perhaps that which has loomed largest in recent times has been the pronounced movement towards increased steam pressures. The thermal advantages to be gained by the adoption of increased steam pressures are illustrated in Table I. The figures hold strictly for a plant consisting of turbines supplied with steam at a total temperature of 700 deg. Fah. exhausting into a vacuum of 29·0in., and equipped with four-stage feed heating, together with necessary auxiliaries for boilers, turbines and condensers.

TABLE I.—*Increase in Steam Pressure for 3 Per Cent. Steps in Thermal Efficiency.*

Basis.—700 deg. Fah. total temperature, 29in. vacuum, four-stage feed heating. Including boiler and condenser auxiliaries. Capacity not less than 40,000 kW M.C.R. at 1500 r.p.m.; 20,000 kW M.C.R. at 3000 r.p.m.; 10,000 kW M.C.R. at 6000 r.p.m.

Increase in thermal efficiency	3%	6%	9%	12%	15%
Initial pressure.		Final	pressure.		
From 200 lb./sq. in. G. to	265	365	505	764	1360
From 250 lb./sq. in. G. to	342	472	703	1200	
From 350 lb./sq. in. G. to	495	755	1390		
From 500 lb./sq. in. G. to	785	1530			
From 750 lb./sq. in. G. to	1470				
From 1400 lb./sq. in. G. to	—				
Reduction in coal consumption	2·92%	5·66%	8·26%	10·71%	13·04%

For 900 Deg. Fah.—Gain with pressure as above between 200 lb. per square inch and 750 lb. per square inch. Gain with pressure increased by ½ per cent. per 100 lb. per square inch between 750 lb. and 1400 lb. per square inch.

For 28in. Vacuum.—Gain with pressure increased by 0·3 per cent. per 100 lb. per square inch between 200 lb. and 750 lb. per square inch. Gain with pressure increased by 0·2 per cent. per 100 lb. per square inch between 750 lb. and 1400 lb. per square inch.

* Inst. of Mech. Engineers. Read before the North-Western Branch in Manchester on January 31st, 1929.

By means of the corrections given below the table, the gains with pressure for other initial temperatures and vacua can be obtained with reasonable accuracy. Thus the increase in thermal efficiency to be expected from raising the pressure from 350 lb. per square inch to 1390 lb. per square inch will be practically 11·37 per cent. if the initial temperature is 900 deg. Fah. and the vacuum 28in.; compared with 9 per cent. when these conditions are 800 deg. Fah. and 29in. respectively.

On theoretical grounds resuperheating the steam to the initial temperature after partial expansion in the turbine by a special reheat boiler might be expected to increase the gain shown in Table I. by 0·125 per cent. per 100 lb. per square inch change in pressure. Experience with resuperheating installations up to the present makes it doubtful if this increased gain will mature, leaving Table I. applicable to schemes including resuperheating to the initial temperature by means of flue gases.

It will be noticed that the "Law of Diminishing Returns" holds in a marked manner. Thus, an increase of 65 lb. per square inch above 200 lb. per square inch gives the same increase in thermal efficiency as an increase of 720 lb. per square inch above 750 lb. per square inch. The percentage decrease in coal consumption being the reciprocal of the increase of efficiency is necessarily somewhat less than the increase in thermal efficiency, and will be found stated at the bottom of the table.

In view of the small changes in thermal efficiency to be effected by small changes in pressures, there should be little well-founded objection to the standardisation of some such series of steam pressures as those given as initial pressures in Table I. Surely there can be no real justification for calling for new plant at such a variety of pressures as 300 lb., 325 lb., 350 lb., 375 lb. and 400 lb. per square inch when the maximum difference of possible efficiency of the extremes from 350 lb. per square inch is but 1¼ per cent. The advantage of such standardisation to boiler, turbine and auxiliary manufacturers would be very real, and therefore of immediate interest to the ultimate purchaser of electricity.

In discussions on the possibility of high pressure steam, the great importance of size of plant is not generally appreciated. It is not without significance that the successful installations using steam either in the region of 550 lb. per square inch or 1200 lb. per square inch utilise what—in the experience of this country—are very large units. It is doubtful, for example, whether at the present time 350 lb. per square inch should be adopted for 3000 r.p.m. condensing plants having a lower M.C.R. rating than 10,000 kW or 500 lb. per square inch for a rating less than 20,000 kW M.C.R. With 1500 r.p.m. plant these ratings should be not less than 20,000 kW and 40,000 kW respectively. It should be clearly stated that these are at the present time the probable minimum desirable ratings for the pressures stated and not necessarily the desirable pressures for these ratings. The figures given in Table I. apply to machines whose ratings are not less than 40,000 kW M.C.R. if operating at 1500 r.p.m., 20,000 kW M.C.R. if at 3000 r.p.m., or 10,000 kW if the high-pressure cylinder is geared up to 6000 r.p.m. For smaller ratings at their respective speeds the thermal gain necessarily will be decreased.

As steam pressures are increased, the desirability of confining the high-pressure expansion range to a separate cylinder also increases. Thus, at 350 lb. per square inch there are decided advantages in a two-cylinder turbine from purely mechanical considerations, while for pressures of 600 lb. per square inch or 1200 lb. per square inch a three-cylinder turbine becomes attractive. In the latter case the first cylinder may be arranged to drive a separate generator, an arrangement which affords the advantage of permitting it to be run at a higher speed than the remaining low-pressure cylinder. Alternatively the high-pressure cylinder might be geared direct to the low or intermediate turbine shaft, but this arrangement has not yet received the compliment of adoption in practice. With geared arrangements it must be remembered that the gear introduces additional losses, which, for instance, would mortgage 25 per cent. of the thermal gain obtainable by increasing the steam pressure from 500 lb. per square inch to 800 lb. per square inch, or from 750 lb. per square inch to 1500 lb. per square inch.

The number of turbine cylinders into which the total expansion and steam flow is divided has been, in recent

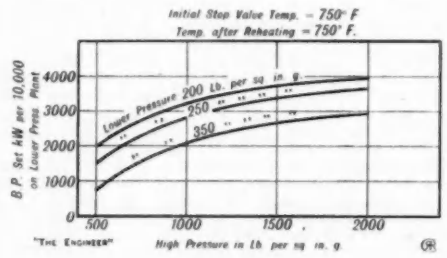


FIG. 2

years, the subject of wide variation, now varying between the extremes of a single cylinder to as many as five cylinders. Generally the tendency appears to be to adopt one or two-cylinder turbines driving a single generator for 350 lb. per square inch, two or three-cylinder machines for 500 lb. or 600 lb. per square inch, and two or three-cylinder machines for pressures of 1000 lb. per square inch or higher, with the first cylinder driving a separate generator and running at a higher speed than the intermediate or L.P. cylinder. A variation of this last case, which at one time attracted a good deal of interest, consists of installing a new bank of high-pressure boilers in a station where a lower pressure is established already, and expanding the steam from them through a back pressure turbine down to the pressure in the existing engine-room mains. On leaving the back pressure turbine the steam should be returned to the new boilers for resuperheating to something like the initial temperature.

Fig. 2 gives the relation between the output of such a back pressure unit in terms of that which the plant operating at the lower pressure will develop with the same total steam quantity.

Thus, consider the case in which new boilers are installed supplying steam at 1200 lb. per square inch and 750 deg. Fah. to a back-pressure turbine, leaving which it is superheated to 750 deg. Fah. before being exhausted to older turbines designed for 200 lb. per square inch. Under these conditions the back-pressure plant will generate 3450 kW for each 10,000 kW generated by the lower pressure plant. It must be clearly understood that this does not represent the gain in kilowatts for the same total coal consumption, but is the gain in prime mover capacity. The reduction in coal consumption can be computed from the relations given in the author's earlier paper, "The Economic Value of Increased Steam Pressure." It is assumed that the lower pressure plant is reasonably efficient of its type. If this is not so, probably the more economical course would be to reserve the older plant for peak load, or else to scrap it, and to install modern plant, using perhaps a pressure intermediate between the two just discussed.

Apart from the considerations already reviewed, the desirable steam pressure still depends on the increase in cost of plant with pressure, the cost of coal, that of money, and the load factor with which the particular plant can be expected to operate averaged for the whole redemption period. Of these, the first and last are the only factors which show any sensible tendency to change. Apparently in this country the additional cost of plant with increasing pressure has on the average decreased about 15 per cent. in the last two years. There is some hope of increasing this rate of improvement so far as very large plant is concerned.

A system of re-superheating by means other than the use of a re-heat boiler has recently demanded attention. In one example of this type a proportion of the steam from the boiler is diverted before the turbine stop valve and condensed in a steam heater placed in a chamber, through which steam from the turbine is passed after partial expansion, and before being returned to the turbine to complete expansion. Such a system is shown diagrammatically on the left-hand side of Fig. 3, where A is the "condensing" resuperheater. The thermal advantage of such a device depends on the pressure at which the steam is resuperheated and on both the pressure and temperature of the steam supplied to the whole system. The pressure at which steam is taken from the turbine to be resuperheated is therefore adopted as abscissa against which other quantities are plotted.

The thermal advantage also depends, very directly, on the extent to which feed heating by bled steam is adopted. In order to simplify investigation, the effect of steam resuperheating, in the first instance will be considered limited to a straight condensing turbine without feed heaters. The advantage of feed heating is included in so far as it is the result of mixing the condensate with the drain from the resuperheater, appearing in the analysis as augmenting the gain from resuperheating.

Curve G in the lower part of Fig. 3 shows the probable maximum thermal gain for the conditions stated, as compared with a turbine supplied with steam at 550 lb. per square inch and a temperature of 750 deg. Fah., but without resuperheating. Thus, if steam is supplied both to the turbine stop valve and the heating coil of resuperheater A at a pressure of 550 lb. per square inch gauge, and a total temperature of 750 deg. Fah., the upper limit of maximum gain is 1·9 per cent. In this case the steam should be taken from the turbine to the resuperheater after having been expanded down to a pressure of 40 lb. per square inch absolute.

In the second case an additional steam resuperheater B of the "de-superheating" type, may be placed immediately after the condensing resuperheater A just described. The whole of the steam supplied from the boilers can be used further to raise the temperature of the steam leaving resuperheater A. In such a system the steam should be supplied from the boilers at a higher temperature than in the first case, and the heating in superheater B being performed at the expense of this additional superheat. Thus, in the diagrammatic arrangement shown on the right side of Fig. 3 steam is assumed to be supplied to resuperheater B at a temperature of 850 deg. Fah. and a pressure of 550 lb. per square inch, so that it reaches either the turbine stop valve or the heating tubes in A at the pressure of 523 lb. per square inch and a temperature of 750 deg. Fah. Under these conditions, the probable maximum thermal gain, without feed heating, except by the drain from the resuperheater, is shown by curve H, and reaches an upper limit of 3·25 per cent. when the resuperheating is performed at a pressure of 35 lb. per square inch.

It is worthy of notice that if, instead of using steam resuperheaters A and B, steam at the same initial conditions of 550 lb. per square inch and 850 deg. Fah. is supplied direct to the turbine stop valve, the upper limit of thermal gain is 3·75 per cent., or slightly greater than in the double resuperheater scheme. Apparently, therefore, the use of a system which includes a resuperheater of the type B would be justified, only on the very doubtful assumption that boiler plant, valves and pipe lines can be successfully operated at considerably higher steam temperatures than steam turbines can be constructed to employ.

The thermal economies of such steam resuperheaters for steam supplied to the system at any pressure from 200 lb. to 1200 lb. per square inch, but without feed heating, except from the resuperheater drain, are plotted in the group of Curves I. in the top left-hand side of Fig. 4. Curves marked "With wetness correction," represent the upper limit of gain. By comparison with the curves marked "No wetness correction," it is obvious that the whole thermal gain depends on decreasing the losses usually associated with wetness. Results in practice can be expected to approximate to the upper limit unless radiation and pressure losses in the reheaters and piping prove to be sensibly greater than assessed in these estimates. The detail design of such reheaters demands the strictest attention towards the elimination of pressure drop through them. It is only where greatest care is taken that the pressure drop can be maintained within the limits which have been assumed.

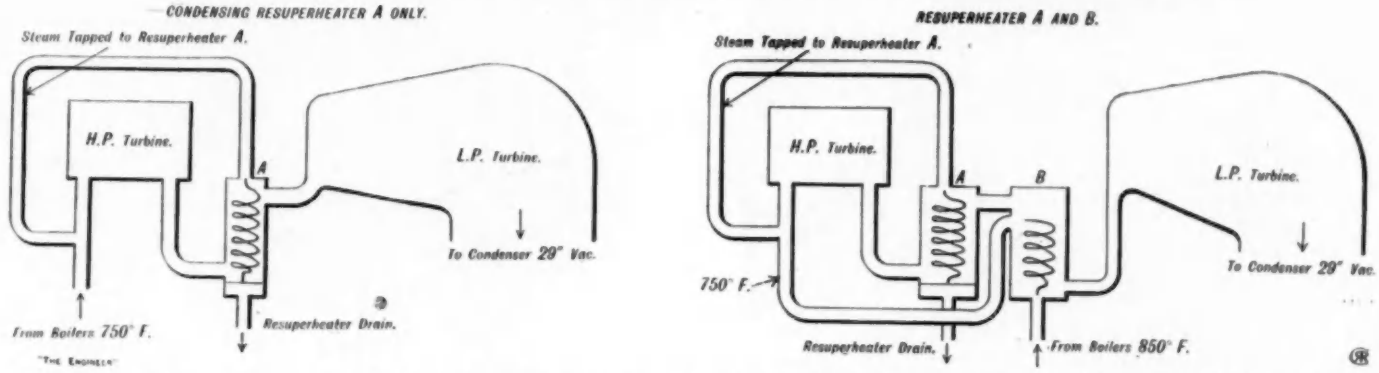
For both types of resuperheaters, the thermal advantage increases rapidly with pressure, being from six to eight times as great at 1200 lb. per square inch as at 200 lb. per square inch. It should, however, be emphasised, as will be shown later, that the thermal advantages of these expedients are drastically reduced by the addition of regenerative feed heating to the plant.

Curves II., Fig. 4, give the pressures at which resuperheating should take place for maximum thermal gain. It should be noticed that the pressure for maximum gain is sensibly the same for both schemes.

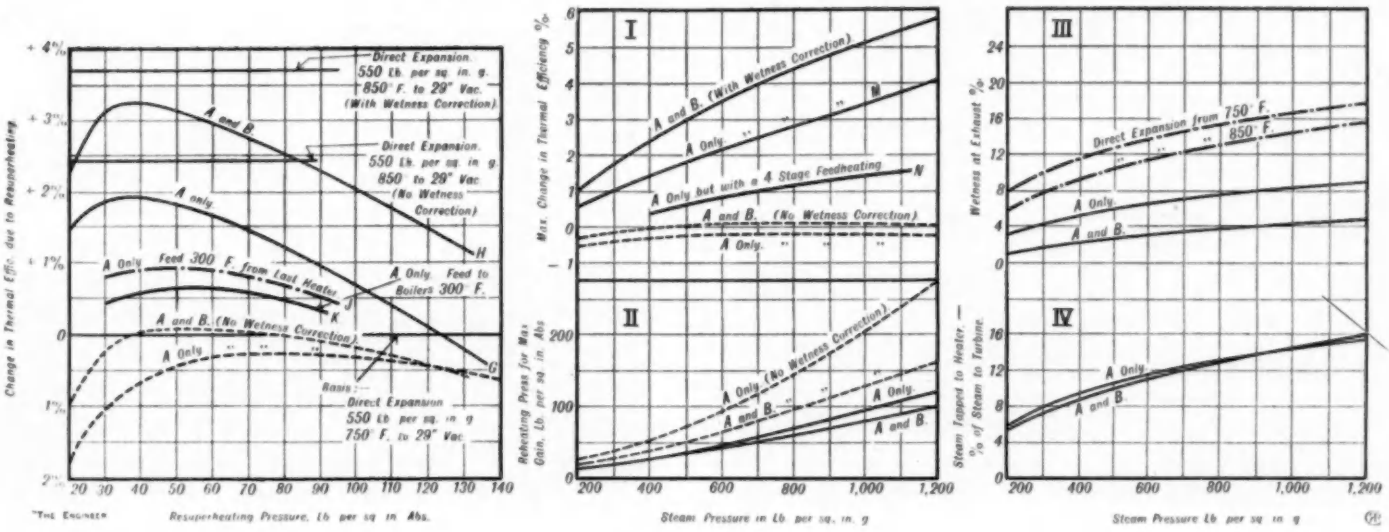
In Curves III., Fig. 4, the wetness at exhaust is plotted for both systems on the usual assumption that expansion takes place under stable conditions. The upper two curves show the final wetness to be expected without resuperheating and with stop valve temperatures at 750 deg. wetness correction is assumed—and the stop valve pressure is 550 lb. per square inch. It will be noticed that whereas the addition of a condensing resuperheater increases the efficiency of the straight condensing set by 2·28 per cent., the advantage of the resuperheater is reduced to 0·75 per cent. if the turbine is equipped with four-stage feed heating. The saving by resuperheating in the feed heater case is augmented slightly further by the improvement in boiler efficiency resulting from the reduc-

Resuperheating is one of the resources available to ensure this end, if pressures of 500 lb. per square inch or higher are to be used. At present there is a decided tendency away from the use of resuperheating by flue gases at least in the medium high-pressure range of from 400–700 lb. per square inch and below that range. The reason is largely, directly or indirectly, associated with the very large steam volumes to be handled to, from and in the resuperheater, since resuperheating is performed at

STEAM RESUPERHEATING SCHEMES.—STEAM FROM BOILERS 550 LBS. PER SQUARE INCH GAUGE.



BASIS.—Steam from boilers falls 5 per cent. in absolute pressure and 100 deg. Fah. in temperature through resuperheater B, if used. Steam to turbine falls 5 per cent. in pressure through steam chest and expands with 80 per cent. dry stage efficiency; it is resuperheated in A to within 10 deg. Fah. of saturation temperature of tapped steam at resuperheater inlet and falls 5 per cent. in pressure through each resuperheater used. Steam tapped to resuperheater A falls 10 per cent. in pressure through resuperheater, and is drained as water at saturation temperature. No feed heating, other than by admixture of resuperheater drain with main condensate, except where stated. No correction for variation in leaving and exhaust losses.


Change in Thermal Effic. due to Resuperheating
Direct Expansion. 550 Lb. per sq. in. g. 850° F. to 29" Vac. (With Wetness Correction)
A and B
Direct Expansion. 550 Lb. per sq. in. g. 850° to 29" Vac. (No Wetness Correction)
A only
H
A Only Feed 300° F. from Last Heater
A Only. Feed to Boilers 300° F.
J
K
A and B. (No Wetness Correction)
A Only
G
Gains:— Direct Expansion 550 Lb. per sq. in. g. 750° F. to 29" Vac.
Resuperheating Pressure, Lb. per sq. in. Abs.
"THE ENGINEER"
I
Max. Change in Thermal Efficiency %
A and B. (With Wetness Correction)
A Only
A Only but with a 4 Stage Feedheating
N
A and B. (No Wetness Correction)
II
Reheating Press. for Max. Gain, Lb. per sq. in. Abs.
A Only (No Wetness Correction)
Steam Pressure in Lb. per sq. in. g.
III
Wetness at Exhaust %
Direct Expansion from 750° F.
850° F.
IV
Steam Tapped to Heater — % of Steam to Turbine
Steam Pressure Lb. per sq. in. g.

FIGS. 3 AND 4

and 850 deg. Fah. respectively. Comparison with the lower two curves emphasises the virtues of steam resuperheating as a drying agent. It is apparent that the use of the condensing resuperheater A alone dries the steam sufficiently to maintain the final wetness within desirable limits throughout the range of pressures considered.

The amount of steam condensed in reheater A is plotted for both cases in Curves IV., Fig. 4.

Contrary to natural expectations, the considerable proportions of the steam condensed in resuperheater A do not relieve the exhaust end of the turbine and the condensing plant to a proportional extent. In the one case the increased dryness increases the specific volume at the last stage and in the other the exhaust steam has a higher total heat. Approximately, the percentage reduction in leaving and exhaust loss for the range of pressures considered varies from one-third to one-half of that which would correspond to the reduction in steam through the exhaust of the turbine. The reduction in heat transmitted to the condenser is negligible, the reduction in exhaust steam being practically balanced by the increase in total heat.

The thermal economies of steam reheating are profoundly affected and reduced by the addition of regenerative feed heating to the system. Pushing the expansion into a dryer region by resuperheating virtually has the effect of reducing the possible gains from feed heating.

In the first case examined, with steam at the stop valve at 550 lb. per square inch, the gain for a condensing resuperheater is given in Fig. 3 by the heavy curves J and K, if the turbine is fitted with four-stage feed heating to 300 deg. and 314 deg. Fah. respectively. Curve K, which rises to a maximum of 0·69 per cent., is obtained on the assumption that the temperature of the feed to the heaters is the same in all cases. On the assumption that the feed is heated by the reheater drain to a higher temperature than without the reheater, Curve J is obtained showing a maximum of 0·9 per cent. gain. The former curve K is the more proper assessment. The maximum gain with feed heating is less than one-half of that possible without feed heating. For other pressures the effect of a moderate degree of feed heating is obtained by comparison of curves M and N in Fig. 4, Curve I. Throughout the range the gain with feed heating is only half to one-third of that without feed heating.

In order to elucidate this important effect further, two series of cases of combined reheating and feed heating are worked out in Table II. for the conditions there stated.

Consider the more optimistic approach—when the full tion in heat it has to supply, and becomes 0·78 per cent. if the boiler plant includes economisers and air preheaters.

With a stop valve pressure of 1100 lb. per square inch, the thermal advantage of the condensing resuperheater on the turbine plant efficiency is 4·21 per cent. with no regenerative feed heaters, but is reduced to 1·72 per cent. in a system designed with four-stage feed heating. The consequent improvement in boiler efficiency will augment this gain to 1·78 per cent.

In the past, resuperheating has been employed for a pressure of 50 lb. to 100 lb. per square inch. The additional apparatus involved is therefore large and costly. Further, the additional apparatus necessary to safeguard the turbine if load is suddenly dropped tends to become complicated and relatively costly. Finally, in the case of flue gas resuperheating, the thermal advantages theoretically expected have not fully matured in practice. For this range there is some tendency to turn to steam resuperheating, and if resuperheating must be employed the steam resuperheating systems just discussed possess

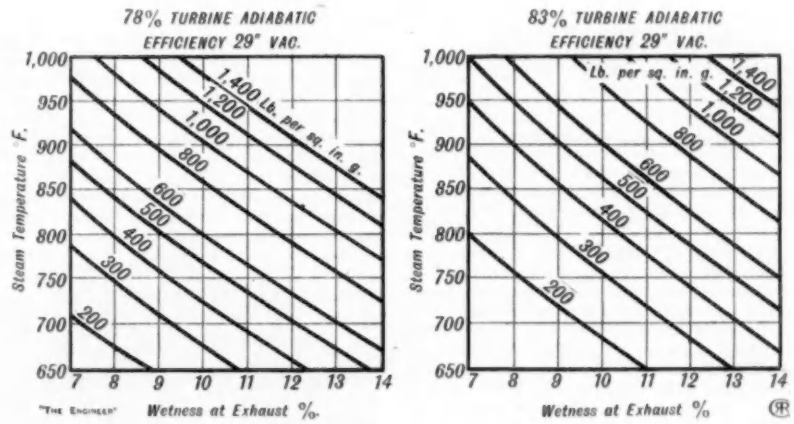


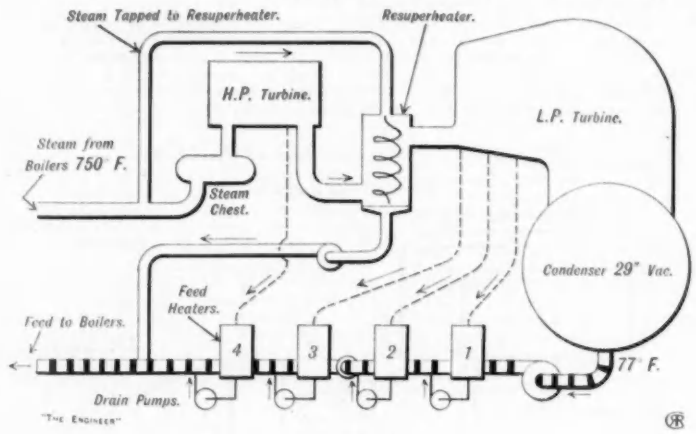
FIG. 5

reasons quite apart from considerations of the increase in thermal efficiency which may flow from its use. As the steam pressure increases, the degree of wetness in the low-pressure stages increases, with consequent increase in tendency to erosion. Further, as the inherent efficiency of turbines has increased, the final wetness under given steam conditions has increased. The bulk of extended experience has been built up with turbine efficiencies and steam conditions which limited the wetness at exhaust between 7 and 10 per cent. There is a very proper concern to maintain final wetness within these limits.

some attraction as a drying agent. The small thermal gain which results should be regarded as a windfall. With flue gas resuperheating, if the initial steam pressure is in the extra high-pressure range of from 1000 lb. to 1500 lb. per square inch resuperheating for maximum advantage takes place at pressures from 170 lb. to 250 lb. per square inch, and the disadvantages of flue gas resuperheating are consequently minimised. The present tendency to retain resuperheating boilers in such cases is therefore probably justified.

Both the advantage and need of resuperheating practic-

TABLE II.—STEAM RESUPERHEATING AND FEED HEATING IN CONJUNCTION.



BASIS.

Steam to turbine falls 5 per cent. in absolute pressure through steam chest and expands with 80 per cent. dry stage efficiency. It is resuperheated between cylinders to within 10 deg. Fah. of the saturation temperature of steam from boilers tapped to the resuperheater and falls 5 per cent. in pressure through resuperheater. Steam tapped to resuperheater falls 10 per cent. in pressure through resuperheater and is drained as water at saturation temperature. Feed is heated by steam tapped at four points on main turbine; saturation temperature of tapped steam to each feed heateris 10 deg. Fah. above the feed outlet temperature. The drain from each heater is returned by a pump to the feed line and the resuperheater drain is mixed with the main feed after the last feed heater.

		A	B	C	D	E	A'	B'	C'	D'	E'
1	Scheme	A	B	C	D	E	A'	B'	C'	D'	E'
2	Pressure at stop valve, lb. per sq. in. gauge	550	550	550	550	550	1100	1100	1100	1100	1100
3	Feed heating by steam tapped from turbine	None	None	4-stage	4-stage	4-stage	None	None	4-stage	4-stage	4-stage
4	Outlet temperature from last feed heater, deg. Fah.	—	—	300	285	300	—	—	300	262·8	300
5	Temperature of feed to boilers, deg. Fah.	77	110·7	300	300	313·9	77	138·2	300	300	332·3
6	Steam resuperheating pressure, lb. per sq. in. abs.	None	50	None	50	50	None	130	None	130	130
7	Temperature of resuperheated steam, deg. Fah.	—	472	—	472	472	—	550	—	550	550
8	Steam tapped to feed heaters, per cent. of steam to turbine	—	—	20·61	18·47	19·63	—	—	21·73	17·02	19·63
9	Sensible heat of feed from last heater, B.Th.U. per lb.	44·9	44·9	269·6	254	269·6	44·9	44·9	269·6	231·5	269·6
10	Sensible heat of feed to boilers, B.Th.U. per lb.	44·9	78·5	269·6	269·6	283·9	44·9	106·0	269·6	269·6	303·1
11	Total heat of steam from boilers, B.Th.U. per lb.	1387·2	1387·2	1387·2	1387·2	1387·2	1362·7	1362·7	1362·7	1362·7	1362·7
12	Heat supplied by resuperheater, B.Th.U. per lb. of steam through resuperheater	—	83·7	—	83·7	83·7	—	114·3	—	114·3	114·3
13	Steam tapped to feed heaters before resuperheater, per cent. of steam to turbine	—	0	—	5·25	5·59	—	0	—	0	0
14	Heat supplied by resuperheater, B.Th.U. per lb. of steam to turbine	—	83·7	—	79·3	79	—	114·3	—	114·3	114·3
15	Steam tapped to resuperheater, per cent. of steam to turbine	—	8·97	—	8·50	8·47	—	13·98	—	13·98	13·98
16	Total heat supplied, B.Th.U. per lb. of steam to turbine	1342·3	1426·0	1117·6	1212·5	1196·6	1317·8	1432·1	1093·1	1245·5	1207·4
17	Wetness loss, per cent.	3·28	1·00	2·93	0·90	0·90	5·64	1·75	5·10	1·56	1·53
18	Wetness at exhaust, per cent.	13·26	7·61	13·26	7·61	7·61	17·65	10·30	17·65	10·30	10·30
19	Change in turbine steam consumption compared with A, per cent.	0	−7·60	+9·11	−0·12	+0·98	0	−11·34	+8·31	−6·38	−4·26
20	Change in total steam consumption compared with A, per cent.	0	+0·69	+9·11	+8·37	+9·54	0	+1·06	+8·31	+6·72	+9·13
21	Change in thermal efficiency compared with A, per cent.	0	+1·85	+10·08	+10·84	+11·0	0	+3·63	+11·29	+13·01	+13·99
22	Difference in thermal efficiency due to resuperheating with constant temperature of feed from last feed heater, per cent.	—	+1·85	—	—	+0·93	—	+3·63	—	—	+2·40
23	Difference in thermal efficiency due to resuperheating with constant temperature of feed to boilers, per cent.	—	—	—	+0·69	—	—	—	—	+1·54	—
24	Reduction in turbine leaving and exhaust losses compared with A, per cent.	0	0·43	1·17	1·23	1·36	0	0·58	1·29	1·47	1·51
25	Corrected difference in thermal efficiency due to resuperheating with constant temperature of feed from last feed heater, per cent.	—	+2·28	—	—	+1·12	—	+4·21	—	—	+2·62
26	Corrected difference in thermal efficiency due to resuperheating with constant temperature of feed to boilers, per cent.	—	—	—	+0·75	—	—	—	—	+1·72	—

ally disappear if it prove possible to work successfully at considerably higher temperatures than are now employed.

The way in which the initial steam temperature should be raised as the initial pressure is raised is exhibited by the curves plotted in Fig. 5. Thus, in order to preserve the same conditions as obtain in the low-pressure end of a turbine operating with 300 lb. per square inch and 700 deg. Fah. initial conditions, the steam temperature must be raised to 830 deg. Fah. if the initial pressure is 600 lb. per square inch *g*., and to over 960 deg. Fah. it it be 1000 lb. per square inch *g*. To generalise, the initial steam temperature must be increased about 40 deg. Fah. for each 100 lb. per square inch increase in pressure, if the wetness in the exhaust end is to be maintained constant. The two sets of curves show how rapidly the wetness at exhaust increases with turbine efficiency. In the range considered, the initial temperature must be increased by approximately 15 deg. Fah. for each 1 per cent. improvement in turbine efficiency if the wetness at exhaust is to remain constant. Unhappily, this resource of increasing the total temperature as the pressure is increased is scarcely consonant with our recently acquired knowledge of the relation between the physical strength of materials and their temperatures.

(To be continued.)

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

LOCOMOTIVE HORSE-POWER.

SIR,—I am greatly indebted to Mr. H. S. F. Sculley for the information he gives on the above named subject.

I see that the cylinder formula assumes that the maximum horse-power is developed at a constant piston speed; now this is perfectly logical, but is it borne out in practice? According to your correspondent, the American Locomotive Company came to this conclusion experimentally, but unless they experimented with engines having widely different piston strokes it does not prove much. If we use the Deeley formula to examine the performance of the Great Western Railway 4–6–0's, one with two cylinders 18½in. by 30in. and the other with four cylinders 15in. by 26in., Cole horse-power 1380 and 1820 respectively, and the same boiler, it will be found that there is very little difference, both machines developing their best power at about 70 m.p.h., the long stroke two-cylinder engine doing slightly better. It is not as if the valve arrangements of these were any better than that of the four-cylinder engine; if anything the latter should have the advantage.

It would seem to me to be much sounder to base the cylinder horse-power on a fixed number of revolutions per minute, that is on cylinder capacity. After all, it must not be overlooked that the motor car world fell into the same error in assuming a constant piston speed on insufficient data; nobody will deny that cubic capacity rating gives a far truer basis of comparison for a motor car engine than does the R.A.C. rating; and if one looks carefully into locomotive performance it will be found that, contrary to expectations, the long-stroke engines generally show up specially well at high speeds.

Doubtless cylinder capacity would not give a true comparison between engines of widely different size, but when one is dealing with those all much of a size the rotational speed seems to set a limit far more than does the piston speed.

With regard to the boiler formula, this should give very comparable results, but I wish it included the fire-box volume; after all the one limiting factor of a boiler's power is its ability to burn fuel, and this is ultimately fixed by the cubic capacity of its combustion space.

C. M. KEILLER.

Cookham Dean, Berks., January 28th.

L.M.S. HIGH-PRESSURE LOCOMOTIVE.

SIR,—The fact that the London, Midland and Scottish Railway Company is about to try a complicated and expensive high-pressure locomotive of German design suggests some interesting considerations. British railway engineers seem always ready to welcome German ideas; in the past we have had such things as Worsdell-von-Borries compounds and Schmidt superheating, and now we are to experiment with pulverised fuel and ultra-high pressure. But for the last thirty years the finest locomotive work in Europe has been done by four-cylinder compound engines of the French type, yet, for some reason which it is impossible to understand, there is not an engine of the type to be found on any railway in this country. A British traveller who has made the usual brilliant run from Paris to Calais, and then crawls miserably from Dover to London behind an overloaded "King Arthur," cannot help wondering what justification there can be for our present locomotive policy.

W. B. THOMPSON.

Pall Mall, S.W. 1, January 26th.

American Engineering News.

Welded Steel Pipe Aqueduct.

AN important part of the works for the East Bay Municipal Water District in California is a steel pipe line, 80 miles long, consisting of two lines of pipe, 54in. to 65in. in diameter. The pipes are made in 30ft. lengths, each consisting of two plates welded together in horizontal seams by means of electric welding machines. For part of its length the pipe lines are buried in the ground, but in peat swamps they are carried in wooden cradles on piles, while in crossing ravines they are supported by concrete piers or steel towers. After the welding has been inspected, each pipe is cleaned by revolving brooms, heated to 450 deg., and then dipped in an asphaltic composition. When the pipe has cooled, it is wrapped with a heavy strip of felt, using hot asphalt as an adhesive. As butt welding of the circular seams proved difficult and unsatisfactory, a change was made to riveted straps, with two rows of rivets in each pipe. In welding experiments it was found that welding rods containing 0·15 to 0·20 per cent. vanadium improved the quality of the work, the welded metal being more close-grained. But where these rods contained more than 0·05 per cent. chromium the penetration of the electric arc is obstructed, and if the current is increased to overcome this difficulty, the welds are porous, hard and brittle. The excess heat thus generated is also likely to result in shrinkage cracks at right angles to the seams. With nickel up to 0·25 per cent. in the rods, the strength of the welds is somewhat increased, but the porosity is also increased.

An American Tank Locomotive.

The use of tank engines is very exceptional on American railways and is confined almost entirely to suburban service. The suburban lines of the Boston and Albany Railroad include a 12½-mile line with fourteen stops in a thirty-five-minute trip, and an 11-mile line with ten stops and a thirty-minute run. For these trips, with no turntables available for rapid turning, the railway has introduced some large tank engines of the 4–6–6 type, having a six-wheeled bogie under a tank and bunker in rear of the cab. There are no side tanks. The engines haul ten steel cars accommodating 100 passengers each. Their main particulars are as follows:—

Cylinders	23½in. by 26in.
Valves	Piston, 14in.; 9in. travel
Valve gear	Baker
Driving wheels	5ft. 3in.
Bogie wheels	2ft. 9in.
Wheel base, driving	15ft.
Wheel base, total	42ft. 8in.
Weight on driving wheels	90 tons
Weight on leading bogie	30 tons
Weight on trailing bogie	50 tons
Weight, total	170 tons
Journals, driving	11in. by 12in. and 10in. by 12in.
Boiler diameter	6ft. 11in.
Boiler pressure	215 lb.
Fire-box	8½ft. by 7ft.
Tubes, fire	234; dia. 2in.
Tubes, superheater	48; dia. 5½in.
Tubes, length	13ft. 6in.
Heating surface, tubes	2548 square feet
Heating surface, fire-box and arch tubes	213 square feet
Heating surface, total	2761 square feet
Superheating surface	788 square feet
Grate area	61 square feet
Water in tank	5000 U.S. galls.
Coal in bunker	6 tons
Tractive force	41,600 lb.

IN his article on "American Couplers" in THE ENGINEER of January 18th, Mr. J. G. B. Sams said it would be interesting to know the number of casualties on the railways of the United States caused by men using their feet to adjust the automatic coupling. On reference to the Inter-State Commerce Commission Accident Bulletin No. 96, for the year ended December 31st, 1927, it will be found that 53 men were injured in that way during the twelve months in question. Ten years earlier, according to Bulletin No. 66, there were nine killed and 236 injured.

OIL ENGINE DRIVEN ROAD-MAKING PLANT

BARFORD AND PERKINS, LTD., PETERBOROUGH, ENGINEERS

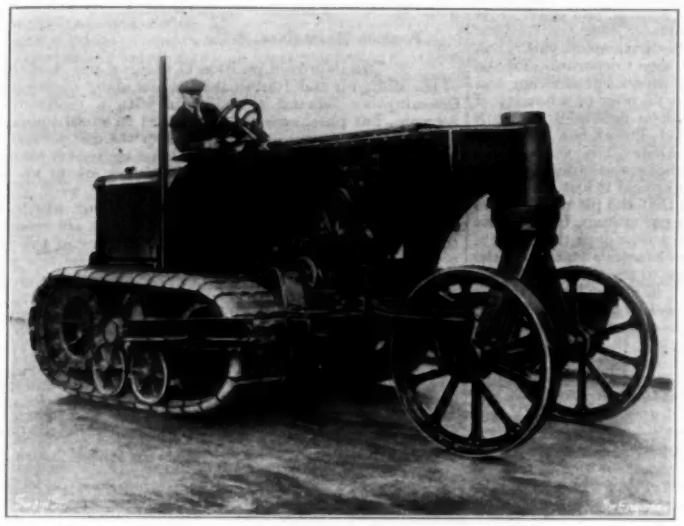


FIG. 1—9-TON CREEPER-TRACK TRACTOR

FIG. 2—ROLLER WITH PRESSURE SCARIFIER

FIG. 3—TRACTOR WITH AIR-COMPRESSOR AND CRANE

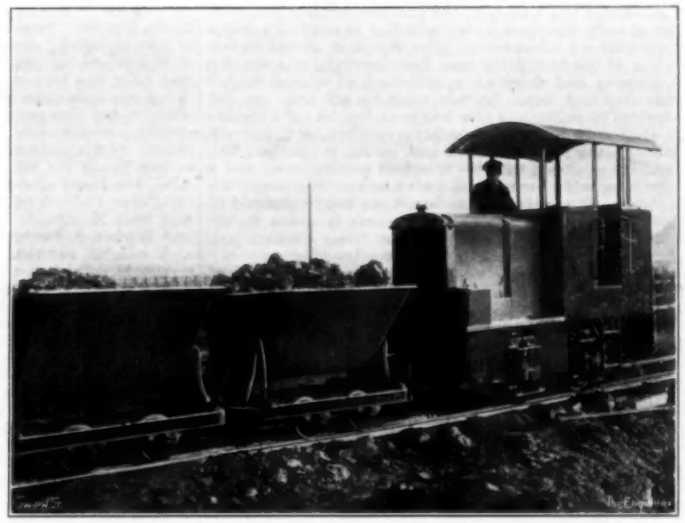


FIG. 4—CONTRACTOR'S LOCOMOTIVE

Oil Engine Driven Road-making Plant.

ON the occasion of a recent visit to the works and trial grounds of Barford and Perkins, Ltd., at Peterborough, we inspected, both in course of erection and also on trial, a wide range of the firm's patented motor road rollers, along with a new series of self-propelled road-making and repairing machines, which are shown in the accompanying illustrations.

In designing these new machines, which embody several interesting features in construction, the firm has sought to adapt its standard design of tractor frame and power unit to the varying needs of each machine. It has now succeeded in introducing a series of models in which a single type of heavy oil engine, gear-box, and transmission gear is employed. This particular feature is noteworthy, as it simplifies to a large extent the problem of repairs and maintenance, which is presented to the public works contractor who finds it necessary to employ a large number of road-making machines of various types. Whether for small town, city or county road-making work the advantages of such standardisation for an effective maintenance service will be at once apparent.

The particular propelling unit which has been chosen for all the machines we herewith illustrate is a two-cylinder, high-speed, airless-injection, oil engine of the McLaren-Benz type. This engine has been successfully employed for ploughing tackle and tractor work for some years, and its main features are familiar to our readers. The recent addition of a small rotary supercharging compressor has increased the available output, and opens new fields of application. The unit chosen is the two-cylinder model, with a bore of 5¼in. and a stroke of 7½in., designed for a normal output of 32 to 35 B.H.P., when running at 800 r.p.m. By supercharging the output can be increased up to about 50 B.H.P. Governor control, which enables the speed of the engine to be regulated down to, say, 250 r.p.m., independently of the load, is provided. It is claimed that the engine will work on a wide range of fuels, varying from brown paraffin and gas oil up to the heavier grades of fuel and tar oils. For convenience in starting, the main engine is equipped with a small air-cooled motor cycle engine of 350 cc. capacity, the pulley of which engages by means of a friction roller with the fly-wheel rim. When it is desired to start the engine, the cylinders are put over to "no-compression" by the movement of a small hand lever and by turning over the main crank shaft, the small engine is started up on petrol fuel. This engine is then accelerated by a hand lever until a speed of 170 to 200 r.p.m. is attained, after which the friction roller is again brought into contact with the periphery of the fly-wheel, the momentum of which is such as to permit the engine to fire on its full compression. The starting of the engine was demonstrated for our inspection, and it appeared to be both simple and efficient.

Another feature of the Barford and Perkins tractor

FIG. 5—TRACTOR PUMPING UNIT

design is the assembly of the engine with its gear-box and transmission shaft on a special sub-frame built up of rolled steel channels welded together. Arrangements are made whereby the sub-frame can easily be lowered and slid out from the rear of the machine for inspection. It forms, together with the steel side plates, the fuel and water tanks, and the head casting in which the patented steering head is housed, a stiffly braced mechanical structure, which is attached by springs to the road wheels.

Having referred to the standardised engine and frame construction, we may proceed to deal with the several machines we saw under test. Fig. 1 illustrates the new creeper tractor, which has a weight of about 9 tons, and is fitted with power-operated steering gear worked by two cone clutches from the gear-box. The engine driving this machine is supercharged. The overall length of the tractor is 17ft. 4½in., with an overall width of 7ft. 7⅞in., and a width of 1ft. 10½in. for each of the two tracks. There are three speeds, the top forward speed being about 3 miles per hour, while the two lower speeds are 1·6 and 0·75 miles per hour respectively, both forward and reverse. The tracks are driven by chains from sprocket wheels on the gear-box shaft. It will be seen that the idlers at the front end of the track are arranged within the track, and are so pivoted that they can move up and down in order to accommodate the track when obstructions are met with, enabling the chassis to maintain its general level. A feature of the track construction, which is of the "Road-less Traction" type, is that track pins are entirely replaced by a system of rubber pads, which are always kept under compression, and therefore do not permit dirt to enter the working joint.

The machine was demonstrated on a section of earth road, and it drew the Howard road grader which was described in THE ENGINEER of September 28th last. Side levelling and ditching operations were also carried out with the same machine, and the creeper tractor certainly seemed to be well adapted for making earth and gravel roads.

In Fig. 2 we show a rear view of one of the firm's standard water ballast rollers, which is fitted with a pressure scarifier worked by compressed air. In the view given eight tines are shown, which would be used for earth and gravel roads, but for water-bound macadam probably the number of tines would be reduced. The scarifier is operated by a single valve, which permits air to pass from the receiver to the vertical power cylinder. A single-cylinder air compressor of the Broom and Wade pattern, with a bore of 3in. and a stroke of 3½in, is fitted. It is designed to run at 800 r.p.m., and it is chain-driven from the main crank shaft at engine speed. The rated capacity of the compressor is 11·5 cubic feet of air, at the speed above named, at 250 lb. pressure, but the scarifier is designed to work at pressures as low as 170 lb., and the relief valve on the air receiver is set for that pressure, at which a total pressure of 5 tons is applied to the scarifier.

Another type of machine which has been built to perform both lifting and transport duties, and also to work

concrete breakers or rock drills, is illustrated in Fig. 3. Over the steering head of the tractor, which is furnished with rubber-tired wheels, there is mounted a 2-ton jib crane of the Herbert Morris type, which is braced and stayed to the tractor frame. The barrel is driven through a friction clutch worked from a cross shaft in the gear-box. The tractor has a hauling drum arranged within one of the rear wheels, which may be used to haul the desired load to a place within the range of the jib crane. These operations were demonstrated. The air compressor on this machine is a twin-cylinder Broom and Wade unit, having 6in. cylinders with a bore of 6½in. It is designed to run at 610 r.p.m., and is driven through a clutch from the cross shaft previously referred to. The compressor has a designed output of 100 cubic feet of air per minute, and there are two air receivers, each of 6 cubic feet capacity, to the end of which two pneumatic tools can be coupled. The air compressor is water-cooled, and is provided with its own radiator and fan. As the machine referred to is designed for general road repair work, it has a top speed of approximately 8 miles per hour, with speeds of 5 and 2·25 miles per hour, both in the forward or reverse direction. The rear wheels are each 5ft. diameter, with a width of 1ft. 3in., and they are fitted with rubber tires. Each of the forward wheels is 3ft. 7½in. diameter, with a width of 6in., and is also rubber shod.

On a similar tractor, shown in Fig. 5, a two-stage centrifugal pump has been mounted, with suitable delivery and suction connections. The pump bed-plate is attached to the main frame of the tractor, and the chain drive is taken from the gear-box direct to the pump shaft. A small clutch is fitted on the gear-box shaft, so that the attendant can throw the pump into action when the tractor has been moved to the required position. On the tractor that we inspected were fitted a 5in. suction valve a 4in. delivery pipe with the usual foot valve, non-return valve, and a delivery control valve. Facilities are provided for inspecting the pump impellers. The pump takes about 20 horsepower, and when running at 1470 r.p.m. is designed to deliver water against a total head of 200ft.

A further adaptation of the standard engine and gear-box already described is shown in Fig. 4, which illustrates a contractor's locomotive. This unit is in actual service in one of the brickfields near Peterborough, and we saw it drawing and shunting a train-load of wagons loaded with clay and iron. In this machine not only are the standard oil engine and gear-box used, but, by the adoption of steel side plates, it has been possible to utilise the ordinary tractor axle-boxes and spring supports. The engine is equipped with the standard starting gear, and a light removable cover gives access to the valves and the controls. The speed change levers are neatly grouped in the attendant's cab, and good access is given to the fuel and water tanks, the attendant being afforded protection from the weather by a light steel awning.

The locomotive has a weight of 5·1 tons and is designed for a 2ft. 5½in. gauge. Its haulage capacity is about 100 tons on the level.

It is of interest to learn that Barford and Perkins, Ltd., are showing their productions at no less than six continental Fairs during the present year, namely Leipzig, Paris, Brussels, Utrecht, Vienna and Prague.

South African Engineering Notes.

Ten Months' Mineral Output.

THE details of the mineral production of the Union for the ten months of 1928, ended October 31st, together with the figures for the corresponding period of 1927 are as follows:—

	1928. £	1927. £
Gold	36,643,700	35,809,433
Silver	104,270	98,455
Osmiridium	74,537	46,106
Platinum	207,191	123,170
Diamonds	—	10,536,326
Coal	3,082,970	3,201,164
Copper	486,645	471,716
Tin	225,654	281,660
Other minerals	412,875	399,021
Totals	£41,237,932	£50,967,051

The Government Mining Department has discontinued publishing the monthly values of the diamonds produced, but from the value of the diamonds exported it would appear that the value of the production for the first ten months of 1928 has been about two millions sterling less than in 1927. It is stated that already diamonds to the value of about six millions have been recovered from the wonderfully rich stretch of ground at Alexander Bay, on the S.W.A. coast, which the Government proclaimed a State digging, and is working. It is also computed that the total value of the diamonds which the stretch contains amounts to about fifteen millions, but it is very probable that further equally rich stretches of diamondiferous ground will be found in that part of the country. The Government states that it will take every precaution to avoid glutting the market, and will only sell a certain quantity yearly, also that a considerable portion of the proceeds of the sales will be devoted to large irrigation schemes.

Steel Companies' Agreement.

The cabled news from London that the South African Iron and Steel Industry Corporation—the concern brought into existence by the South African Government and its parliamentary majority—and the Union Steel Corporation of South Africa, Ltd., have come to a satisfactory agreement has been received in the Union with gratification. The full text of the agreement is not available as yet, but it is understood that, broadly, the South African Iron and Steel Industrial Corporation will concentrate generally on the production of ordinary primary steel products and the Union Steel Corporation will gradually cease to be a producer of such products, excepting tube steel, which it is to supply to the Stewarts and Lloyds works for the production of pipes and tubes. The Corporation will continue to produce pig iron and run its blast-furnace exactly as to-day, and there will be no limit on the present producing capacity. In addition, it has the right to manufacture iron pipes, steel and iron castings, and railway chairs. No doubt it will also continue to manufacture reinforcing steel rods, steel rounds, squares, flats, angles, tees, and channels, tube mill parts, tooth gearing, steel shafting and forgings, and other of its present leading lines. It is also stated that the Government, as the result of this amicable settlement, will, when next application is made by the Union Corporation for the steel bounty, not only grant it on present production, but also on past production. There is an offer of a bounty of 15s. per ton for each ton of pig iron produced in South Africa from local iron ore, provided that not less than 50,000 tons be produced annually. The Corporation applied for the bounty some time back, and obtained judgment in the lower courts, but on appeal it lost, the court holding that it was not sufficient that the plant should be capable of producing 50,000 tons per annum, but it must actually do so. If the Government now pays the bounty, it will be regarded as the most satisfactory feature of the settlement, as the main opposition to the State works has been on account of the apparent intention to crush out private enterprise, which the refusal to pay the bounty—together with other incidents—appeared to indicate. Two factors have probably influenced the Government in coming to an agreement with the Union Steel Corporation, the first being that the public has evinced no desire to invest in the new State enterprise, and, owing to the agreement, much less capital will now be required, and, secondly, a desire to reassure private enterprise, it being known that the fear of having to meet Government competition has caused several overseas firms to refrain from erecting works here until they received satisfactory assurances.

Electric Power Production.

With an annual output which exceeds 1,000,000,000 units, the Witwatersrand electrical industry now claims to be the largest fuel-generated power producer in the Empire. South Africa has now realised that most of the industrial development in Europe and America is due to readily available supplies of cheap electricity, and what has been accomplished on the Witwatersrand is but one indication of the sure advances that have been made in the Union in the use of electricity. The whole system is firmly based, and rapid developments are taking place. At the present time all the large electrical schemes in the Union are restricted to about five limited areas. After the Rand scheme, these are the Cape Town municipal area, Colenso railway electrification section, Durban and Port Elizabeth. On the Rand and at Cape Town and Durban it has been found essential to aim at cheap and reliable methods of inter-connection as being an economic necessity.

The largest single generators in South Africa have a total capacity of 20,000 kilowatts. There are now five of them in the country, all being installed at Witbank, where notable extensions have recently been made. Johannesburg has a municipal power plant with a total capacity exceeding 20,000 kilowatts, and so have Durban and Cape Town. South Africa has sixty further municipal stations, the capacities of which range from the 30 kilowatts of Humansdorp to the 10,500 kilowatts of Pretoria. Interconnection plays a very large part in the Rand power industry. The five powerful stations of which it is composed are connected by duplicate, triplicate and quadruplicate transmission wires, and the pressures there range from 40,000 volts to 132,000 volts. The Victoria Falls and Transvaal Power Company owns four of these stations. The fifth belongs to the Electricity Supply Commission of South Africa. It began work in 1927, and by the end of that year had produced nearly 400,000,000 units. Marked advances in respect of inter-connection have been made in Cape Town and Durban. The new power station built at Salt River for the electrification of the suburban lines has been inter-connected with the old Cape Town Municipal Power Station in Dock-road. The direct result of this is the supplying of villages and municipalities lying considerable distances away. The Electricity Supply Commission's new power station at Congella is being connected with that of the Durban Municipality, so that adjacent towns may be supplied, and the electrical expansion of the town assured. A great feature of the new Durban undertaking, a result of which is the scrapping of the old power station in Dutch-road, is the fact that it employs such excellent business methods as the extension of hire purchase facilities in connection with household and industrial appliances, and such other means as assisted wiring and erection schemes to popularise electricity. Such enterprise creates a precedent in South Africa. Although the power stations built within the last few years at Bloemfontein and Pretoria are much smaller than those in the larger South African cities, rapid electrical expansion is taking place. A certain electrical development of the near future is the extension of the electrified railway system, from Maritzburg to Durban, and power for this purpose will probably be obtained by inter-connecting the Congella station with that at Colenso. This will enable many municipalities at present without electricity to embark on such schemes. Some have availed themselves of the facilities now offered. Further interconnection will increase these opportunities and raise railway electrical efficiency.

Building of Bogies and Wagons.

Provided that the State Iron and Steel Works can produce first-class heavy steel, it is possible that a private concern may be established to build railway bogies and wagons in the Union. At present the uncertainty about the potential output of the State Works limits the scheme to tentative feelers, but when that uncertainty is cleared up the matter will assume definite shape. It is also stated officially by the Railway Administration that certain offers have been received for the establishment of a central workshop under private auspices, and that these proposals are receiving attention.

A PROMISING deposit of nickel ore has been discovered in the Gwanda district of Southern Rhodesia.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Position Maintained.

THE improved position of the iron and steel trade of the Midlands and Staffordshire is just about maintained. Consumptive demand is moderate with a tendency to increase, but purchases are kept down to small tonnages. Conditions in the engineering trades of the district remain uneven, so that, though there is a good aggregate tonnage of iron and steel changing hands, orders are of no size and come from different sources week by week. The consuming works are absorbing more labour, which is a happy sign, and manufacturers' order books are reported to be gaining in bulk. The firm, bright tone of the Birmingham iron market is upheld. Chief interest this week has centred in raw iron, where makers have been fighting for a substantial advance in prices. There has been no movement of moment in finished iron or steel values.

Blast-furnacemen Confer.

On Thursday last week a number of Midland blast-furnacemen held a conference in Birmingham to consider the position of the pig iron industry. The conference was presided over by Sir Francis Joseph (North Staffordshire), at whose instance it was held, and the districts stated to be represented were Staffordshire, Leicestershire, Derbyshire, Northamptonshire, Lincolnshire, Yorkshire and Lancashire. The proceedings were private, and those who attended express a disinclination to refer to details. It appeared to be admitted that the object of the meeting was to bring about solidarity in the trade. It was denied that any organisation had been formed. The tenor of the deliberations was indicated, however, by the subsequent announcement to merchants and consumers of a general advance of half a crown per ton in prices. The meeting, I understand, dissolved with an understanding that it would be called together again, efforts being made in the meantime to place the movement on a fully representative basis.

Pig Iron Price Controversy.

The concerted move by Midland blast-furnacemen last week to place prices on a higher level has thoroughly upset the market, and at the time of writing business is stagnant, though inquiries come in day by day. Sellers, it would appear, are adhering to the new quotations with more solidarity than consumers had thought was likely to prove the case, and, moreover, efforts are being made, I understand, to bring into line the furnaces which were not parties to last week's agreement. If this can be brought about, smelters express the opinion that they will be able to carry through the project of putting values on a more economic basis. Users contend that the market is not ready for any advance in pig iron prices, and hold that the increasing stocks at the furnaces will compel makers in the near future to adopt a new line of thought. An all-round increase of half a crown, they maintain, they are not prepared to concede, and so they are holding off the market, and business in this department is suspended. It is asserted that many, if not most, of the large consumers are fairly well covered, so far as the requirements of the current quarter are concerned, and they have no need to buy until they see how the market settles down. Derbyshire pig, it should be pointed out, on account of the closing down of some Northern furnaces, is not in such copious supply as it formerly was. Northamptonshire furnacemen have found a market for some of their output in Scotland, while a few orders, alike for basic and foundry material, have been obtained from the Continent. Despite these facts, up till now the initiative has been with buyers, and they are not prepared to forego this advantage without a struggle. To-day's meeting in Birmingham may give some indication of how things are likely to go, but at the moment Derbyshire No. 3 foundry is quoted £3 2s. 6d., forge £2 18s. 6d., Northamptonshire foundry £2 17s. 6d., forge £2 14s., and all efforts to secure supplies at lower prices met, as far as I can ascertain, with no success. East Coast hematite is firm at £3 11s., and Welsh hematite at the same price. The carriage charge on the Welsh material is rather less than that of North-Eastern, and most of the material bought comes from South Wales. Scotch iron at £3 10s. at the furnaces and 21s. to be added for carriage is too dear to buy in this district.

Blast-furnace Coke.

Ovenmen supplying the Midlands are quoting higher prices for coke to the blast-furnaces, 14s. to 14s. 6d. f.o.t. being asked. The market can scarcely be said to be stronger in view of the further curtailment of the output of pig iron. It is to be presumed that the demand is based on the recent grant of a State rebate on transport costs, to the benefit of which both the buyer and seller of blast-furnace fuel still lay claim.

Steel Prices.

The decision of the Steelmasters' Association to maintain prices at recent ruling rates gave fairly general satisfaction. While there is a slightly growing demand for finished steel, consumption is still on a moderate scale, and a rise in values might easily have led to a falling away of business. Angles and joists on the basis of £7 17s. 6d. and tees at £8 17s. 6d., less rebate, have, if anything, sold better this past week, while there has also been an improved inquiry for ship, bridge and tank plates at £8 12s. 6d. With the Continent keeping up its prices for steel, British producers continue to get the offer of most of the orders that are being placed. The re-rolling works are fairly active, and are able to sell steel bars rolled from foreign material at £7 15s., as they are working upon stocks which were bought when foreign prices were very low. Foreign suppliers are not pressing their material on the market, and prices are maintained at the levels of a week ago. For 2in. billets, £6 2s. 6d. delivered is the usual price, but merchants have English billets to sell at £6 5s., so that

there is very little point in placing orders abroad, especially when the long delay in delivery is taken into account. Many consumers who habitually use foreign material are holding off the market as they have ample stocks, and are quite content to await events. Steelmasters in this district hope for an even more favourable position as regards continental competition in the near future. They continue to stress to consumers the advantages to be obtained by purchasing native material, particularly now that many authorities are stipulating British steel in their contracts. This is a tendency which they say will increase.

Galvanised Sheets.

The galvanised sheet trade is very brisk. Business has been placed freely, and makers are well placed, so that they will not entertain business in 24 gauge corrugateds at below £13 12s. 6d. An increasing number of firms demand £13 15s. The black sheet trade also shows improvement. Galvanised sheet mills have work in hand for at least two months. Output in a few instances is reported to be booked up for as long as three months ahead.

Finished Iron.

The improvement in the finished iron trade is maintained, though it is not very widely diffused, and the reserve of orders is still not very large. There is, fortunately, a number of marked bar makers who report themselves to be in a much better position than recently. Some mills are running regularly, and have three weeks' work on the books. At the weekly meeting in Birmingham to-day—Thursday—there was a steady demand for marked bars at £12 a ton. Chain and cable iron has been in better request during the last few weeks. Crown iron of Staffordshire make sells slowly, competition from other districts at prices considerably below those of local makers persisting. The market level is as a week ago. The call for common bars is a limited one. These are quoted by district makers £8 10s. to £8 17s. 6d., a price which is out of the running in competition with Belgian iron. The trade is consoling itself, however, with the steady rise in the price of continental materials. No. 3 iron, which Black Country nut and bolt makers have bought from Belgium in large quantities in the past, now costs £7 5s. when delivered at makers' works. This material twelve months ago could be had for £6. At to-day's figure, however, it still leaves a good margin as compared with Staffordshire iron in favour of the foreigner. Nevertheless, continental material at present is a very slow market. Wrought iron gas tube strip is steady at £10 12s. 6d., and purchases are freely made. Ironmasters who have converted their plant for the re-rolling of steel are fairly active competing very successfully with the steelmasters. Stocks of foreign billets and bars were bought when prices were low, and mills are still able to sell at £7 15s.

Black Country Chain Trade.

Mr. C. H. Stich, at the annual meeting of the South Staffordshire Chainmakers' and Strikers' Association, of which he is secretary, held on Monday at Cradley Heath, alluded to the outlook for the trade and pointed out that the prospects in the shipbuilding industry, on which the chain trade was so much dependent, showed a more hopeful state of affairs. He would be more than surprised, he said, if there was not a better time in store for the chain industry. In his annual report he expressed regret that the Association had not been able to take any action with respect to the material which members were compelled to use, chiefly in the manufacture of end-welded chains. Some English firms were rolling iron similar in substance to the foreign brands.

Tubes.

The tube works of South Staffordshire are, taken on the whole, fairly busy just now, and are consuming quite large tonnages of both iron and steel. In the weldless section, the call is steady for engines of all descriptions, a fair volume from the shipyards coming through, as well as from the automobile industry, while in the lap-welded section of the trade the general demand is pretty brisk. There is severe competition, however, from the Continent, and prices are necessarily cut to a fine point. South Staffordshire and Black Country firms are, however, holding their own, though they would like to see their output put on a more profitable basis.

Birmingham to U.S.A.

Birmingham and district manufacturers exported more goods to the United States last year than in 1927, notwithstanding a decline in the fourth quarter. The records of the American Consul, give the total values as 8,533,407 dollars for 1928, as against 7,738,233 dollars for 1927. Exports to Porto Rico and the Philippines also increased. It is of interest to record that useful business sprang up in steel tubing, shipments representing a value of 742,171 dollars. Apart from a small export of tinned sheets, general iron and steel manufactures shrank considerably, the value being 139,254 dollars against 478,676 dollars. Steel sashes decreased 268,534 dollars, against 303,202 dollars. Brass exports showed a slight improvement on the twelve months, the turnover being 227,087 dollars against 220,497 dollars. A total of 313,502 dollars was realised for other metal manufactures, compared with 398,033 dollars in 1927. In spite of a strong finish, machinery and vehicles contributed only 171,012 dollars to the aggregate exports, against 197,368 dollars in the previous year. The value for the fourth quarter's trade was 84,162 dollars, double the amount in the corresponding period. More needles were sent to the United States from Redditch. The total for the year was 629,999 dollars against 564,666 dollars.

Coventry's £100,000 Abattoir Scheme.

A comprehensive scheme for the provision of a public abattoir at Coventry at an estimated capital cost of £100,975 is to be placed before Coventry City Council by the Public Health Committee. The question of establishing an abattoir has engaged the attention of the Corporation for several years, but the selection of a suitable site has always presented difficulties. A site has now been chosen and recommended. I understand that the estimated cost of the scheme is:—Abattoir buildings and equipment, £49,000; meat market, cold storage and garage, £27,000; offices, &c. and superintendent's house, £3000; railway siding, £975; loading stages, £1000; roads, paving and fences, £5000; amount charged for site, £15,000; total, £100,975.

Better Demand for Coal.

The recent severe weather has brought about an improvement in the coal trade of Cannock Chase. Since the beginning of the present year demand has been gradually growing, so that with this added fillip some of the collieries are able to work a five-day week. Industrial coal is in better demand, as well as the domestic qualities. The number of miners signing on at Cannock labour exchange for part-time unemployment pay is now about 4300, a decrease of 1000 compared with a month ago.

The Late Colonel Walduck.

Colonel H. J. Walduck, of Caspidge House, Finstall, Bromsgrove, who died in Ceylon on the 23rd inst., was well known and highly respected in Midland engineering circles. He was chairman and managing director of Ludlow Brothers (1913), Ltd., and associated companies, and was engaged on a business mission at the time of his death. His primary interests were in the hollow-ware trade. For some years he was chairman of the Wrought Hollow-ware Manufacturers' Association, and he was chairman of the Wrought Hollow-ware Trade Board from its formation in 1914. As a member of the Birmingham Chamber of Commerce, he had served as chairman of the General Purposes Committee before becoming President in the years 1927–28. Last year he was chairman of the British Industries Fair Management Committee. Colonel Walduck was also a member of the Birmingham Exchange.

Unemployment.

A further reduction this week of 2106 in the number of unemployed in the Midlands area brings the total down to 194,029. Of these, 140,391 are men, 44,109 women, 4581 boys, and 4948 girls. The total for the Birmingham area is 27,643, as against 28,062 a week ago.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Self-help in Industry.

A SPIRITED appeal for greater efficiency in industry, contained in a letter addressed by Mr. A. J. T. Taylor to the Prime Minister, has received wide publicity during the past few days. Whilst conceding that State control and Safeguarding, if rightly applied, may be apt remedies for some of the outlying problems of to-day, Mr. Taylor, who is chairman of Craven Brothers (Manchester), Ltd., machine tool makers and crane builders, of Vauxhall Works, Reddish, near Manchester, asserts that industrial efficiency is the only remedy for the massive central problem of industrial depression. His argument is that the best safeguard against competition is the latest machinery and most efficient processes which the technique of modern science puts at the disposal of employers. Mr. Taylor expresses the conviction that necessary replacements and improvements of machinery are being held up by industrialists merely because the lure of the Safeguarding duty is being dangled before their eyes. New methods and markets should be carefully studied, and full advantage taken of any favourable conditions. If, then, it can be shown that without protection the position is hopeless from a competitive point of view, an appeal for Government help, he concludes, would be justified.

A Conference on "Tubes."

Little has been heard of late of underground railways in Manchester as a solution of the traffic congestion problem, although a year or so ago two, at least, well-supported schemes came under serious discussion. The question has cropped up again in a somewhat wider form, and the possibility is now suggested of an early joint conference of local authorities within a radius of about 15 miles of Manchester with a view to discussing the extension of an underground railway scheme to towns in that area. Such a radius would embrace, in addition to Manchester and Salford, a number of important towns in Lancashire, Cheshire and Derbyshire, including Oldham, Bolton, Stockport, Stretford, Ashton-under-Lyne, Hyde, Dukinfield, Glossop, Royton, Shaw, Macclesfield, Altrincham, and Bury. A prominent official part in such a conference, if it matures, would probably be taken by the members of the Manchester Corporation Underground Railway Committee.

The Change to "Automatics."

A steady development in the growth of the telephone system in this area is indicated in the annual report of the Manchester Telegraph and Telephone Advisory Committee. During the twelve months ended December 31st last, the number of new telephones fitted was 8999, and after allowing for cessations the net increase was 5091, or 6·2 per cent. above the figure for the end of December, 1927. A good deal of space in the report is devoted to the change-over to automatic telephones in the Manchester district. Progress on Telephone House, in Chapel-street, Salford, was seriously delayed during the past year by a plasterers' strike, though efforts are being made to complete certain parts of the building, so that the installation of the advance manual switchboard required in connection with the opening of the Ardwick, Collyhurst and Moss Side automatic exchanges may be begun at an early date. The main scheme provides for the opening of the first automatic unit of 10,000 lines, to be known as "Blackfriars," in the Chapel-street building in 1931. The erection of new buildings has been commenced for automatic exchanges at Trafford Park, Stretford, and Gatley, and a new building at Heaton Moor has been completed in readiness for the installation of the automatic equipment. The greater part of the duct and cabling work involved in the Manchester automatic conversion scheme has, it is reported, now been satisfactorily completed.

Underground Cable Extensions.

The report of the Committee points out that additional cables have been provided from Manchester to Ashton, Rochdale, Middleton, Macclesfield, Chinley, and Buxton, and that work is in progress on new cables from Manchester to Trafford Park, Chorlton, Preston, Liverpool, and Leeds. Schemes are also under consideration for the provision of further cables to Heaton Moor, Stockport, Denton, and Chester. The local system of underground cables is now so extensive that, in the event of serious damage to overhead plant by storms, alternative emergency circuits can be provided with little or no delay. The emergency scheme has proved satisfactory on several occasions during the past year, and traffic delays due to storm have thus been obviated. Experiments were carried out on the utilisation of underground telephone circuits for the purpose of long-distance transmission of pictures. These experiments proved successful, and private wire circuits for the leading newspapers were brought into use, and are now working satisfactorily between London and Manchester and between Manchester and Glasgow.

The Airport Scheme.

The Aerodrome Committee of the Manchester Corporation has decided to recommend the City Council at its February meeting to approve of the estimate of the expenditure in connection with the preparation of the landing ground and the construction of hangars and workshops in connection with the aerodrome scheme at Chat Moss. It is understood that the Air Ministry has now approved of the modified plans submitted, and it is expected that if the estimates receive the final approval of the City Council, the aerodrome will be ready for use in about six months' time. The Corporation is said to be in negotiation with a private company with a view to the latter taking over the running arrangements.

Gas Production at Partington.

The first half-unit of the plant, consisting of vertical retorts, at the new Partington Gasworks of the Manchester Corporation, started production on Friday of last week, the gas being conveyed through a ten-mile 36in. steel trunk main to the Corporation's Gaythorn Works for distribution. The second half-unit consists of horizontal retorts and is expected to be ready for producing later in the year.

A Power and Lighting Committee?

A proposal to be placed before the next meeting of the Manchester City Council is that the Gas and Electricity Committees, which represent undertakings of a total capitalised value of about £10,000,000, should be merged under the title of the Power and Lighting Committee, and that the control of both undertakings should be vested in this body.

Reconditioning a Veteran.

The Mersey Docks and Harbour Board has presented "The Lion," a locomotive which was built at Leeds in 1838 for the Liverpool–Manchester Railway, to the Liverpool Engineering Society, and a fund has been organised for the purpose of meeting the cost of necessary reconditioning work. "The Lion" is expected to take a prominent part in the Liverpool–Manchester Railway centenary celebrations next year. Until recently this veteran locomotive was engaged in connection with the operation of a pump at the Princess Graving Dock, Liverpool.

Non-ferrous Metals.

A sharp rise in copper and an equally abrupt movement in the opposite direction in the case of tin have been the principal features of interest in the market for non-ferrous metals since my last report. Buying interest in the latter metal is naturally not improved by the present weakness of prices, which have been anything but certain in their movements since about the beginning of December. The fact that stocks of tin in this country display a tendency to increase can hardly be taken as a "bullish" factor. On balance, compared with a week ago, quotations for tin at the moment of writing have fallen by nearly £3 a ton. Activity in copper is maintained at a high level, and this, coupled, of course, with the remarkably strong position of producers, serves to keep values moving steadily upward. Prices closed very firm at the end of last week, but there has been a continued upward movement since, making standard cash metal about £1 10s. a ton dearer than a week ago, and forward about 15s. higher. There has been a moderate weight of business in both spelter and lead; the former is fractionally dearer on the week, with lead steady and about unchanged.

Iron and Steel.

The selling position of foundry iron on this market during the past week has not been improved by the price fluctuations that have occurred. A week ago reference was made in this column to an advance of 2s. 6d. a ton by a Staffordshire firm of producers. Later in the week this lead was followed by other Midland makers, but at the beginning of the present week there was very definite evidence of a split in the ranks, and while certain sections were nominally very firm at from 70s. per ton upwards, delivered Manchester, or equal, others were prepared to sell at about 69s. per ton, which represents a rise of 1s. to 1s. 6d. compared with the prices current about a week ago. The net result, so far as fresh sales are concerned, is that consumers appear to be content for the time being to watch developments. Middlesbrough iron is quoted at about 79s. per ton, delivered Manchester, with Scottish rather dearer at 89s. to 90s., and hematite at about 83s. 6d.

Trade in the steel department is on much the same lines as at my last report. There is somewhat better movement of constructional materials, but in very few instances are buyers operating forward ; boiler plates are a rather quiet section at the moment ; whilst a fairly steady demand is reported for small bars, particularly of the bright-drawn variety. Quotations are remarkably firm all round, and a similar remark applies to continental steels, more particularly "semis." In the latter case, buyers locally appear to be doing little more than "nibble."

BARROW-IN-FURNESS.

Hematite.

There is little change in the hematite pig iron trade, which continues steady, with most of the demand coming from home customers. This steady trade has had the result of bringing stocks down, although some of the works in Cumberland still have a certain tonnage to dispose of. If trade continues on the same grade as at present these stocks should be cleared, and then there will be some chance of another furnace or two being put into blast. One furnace in Cumberland has been put out of action, but it had been engaged exclusively on manganese. The local steel works are still taking a fair tonnage of iron, and this fact is helping in the general clearance. Business with the Continent is moderate, and small orders are being booked. Trade with America is up and down. The local iron ore trade remains about the same. Outside buyers are taking the better sorts, but there is still plenty of room for expansion. Foreign ore is in moderate demand, and is being imported in restricted tonnage. The steel trade is not as good as one could wish. The mills are at work on railway material, but the orders held are not bulky, and fresh orders are required if the works are to be kept going for a long period.

Engineering.

It is evident that some of the departments connected with Vickers-Armstrong's activities in the south are to be removed to Barrow with a view to centralisation. A number of draughtsmen have arrived at Barrow connected with the field carriage mountings department, and it is likely that these mountings will in future be turned out from the Barrow works.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

THERE is little or no change to record in the condition of the open-hearth steel trade in this district. The demand for the lower basic grades keeps up well, but trade in acid qualities is still on the restricted scale of the latter part of last year. An additional furnace has been put into operation at the Penistone works of Cammell Laird and Co., Ltd. Progress in North Lincolnshire continues. It is expected that the steel plant at the Redbourne Hill works, Scunthorpe, will be started in the middle of this month. The activity prevailing in that area is shown by the fact that the new No. 6 blast-furnace at Appleby Ironworks has produced over 1900 tons of iron in one week, thus beating all previous Scunthorpe records by over 100 tons.

Railway and Other Work.

Usually, a very considerable part of the acid open-hearth steel produced in Sheffield is employed in the manufacture of railway material, but that branch of trade has now been poorly employed for some time. There is, at present, some improvement in the amount of work on hand for railways overseas, and prospects of further improvement ; but companies at home are still buying axles, tires, and springs on a very restricted scale. Wagon construction for collieries has been in a stagnant condition for a twelvemonth, and there is no sign of a resuscitation. One firm of railway material manufacturers, which specialises largely on buffers, is fully active—namely, George Turton, Platts and Co., Ltd.—the Meadow Hall works of which, while not quite so busy as in recent years, have on hand many considerable orders for steel buffers, and this department is kept going at full time. It is expected that further orders will be received shortly, which will enable the night shift to be restarted. At the firm's Savile-street works, the permanent way department has good orders, one contract for rail keys being sufficient to provide night and day work for three months. The drop stamping and spring departments are also fully employed, with gradually increasing output. There is hope of increased business coming to Sheffield in consequence of the shipbuilding improvement on the North-East Coast. Some time must elapse, however, before the benefit is felt locally, as work on the recently ordered vessels has not made much progress yet. At the rolling mills, work is short in the rod and bar departments, but the forges have moderate orders on hand. The demand for colliery ropes, which has been poor for a year, shows no improvement, and competition for the business is extremely keen, despite schemes for the regulation of prices and sharing of trade. There is fairly brisk business in cold-worked steel and drop stampings. The motor vehicle industry continues to be one of the best customers for Sheffield products. Its demands are scarcely up to former averages, but still they represent a great amount of work, which is shared by many firms. There is an increasing call for special kinds of steel, to meet the requirements of the newer trades and recent manufacturing developments.

Prices Hardening.

A general rise in the prices of iron and steel material as the year proceeds is the opinion of some authorities. Instances of this are already to be found. Soft basic billets were advanced a short time ago, and last week hard basic billets went up by 2s. 6d. to 7s. 6d. per ton. Basic scrap has become at least 5s. a ton dearer during the last few months. Midlands producers of pig iron are proposing a general advance of 2s. 6d. per ton. At least one of the rolling mills has intimated its intention of charging 10s. per ton increase on rolled bars and sheets. While these rises are small, they have the effect of reducing the advantage offered to British trade by the higher continental prices, and making it more difficult to compete for business in markets overseas. The increases are justified on the ground that the policy of working either for no profit or for a loss must cease, and some producers say that higher prices are the only alternative to closing down.

Cutlery and Plate.

Speaking generally, conditions are quiet in both the cutlery and plate trades, though large orders have been placed for cheap goods. Last year a good many firms had to be content without profit, and there were cases in which losses were sustained. A substantial reduction in the prices of nickel silvers is announced by suppliers of metals to the spoon and fork and electro-plate trades. They hope that this concession will assist manufacturing firms to sell finished goods of reliable quality worthy of the reputation of Sheffield. The margin between the selling prices of best and inferior goods is considerably narrowed by this reduction A celluloid substitute which is claimed to be non-inflammable, unshrinkable, and durable, is being adopted by some of the leading cutlery houses for the hafting of table knives.

Tugs and Trawlers.

Two steel screw tugs were launched last Saturday from the Ouse shipbuilding yard of Cochrane and Sons, Ltd., Selby. They are 100ft. long by 25ft. broad, and are to be used at the port of Hull. Messrs. Cochrane have on hand orders for a number of drifters and other vessels, which will provide work for some time. There is prospect of a good number of new trawlers being required if the scheme for a new fish dock at Grimsby materialises. Mr. W. J. Womersley, Member of Parliament for Grimsby, speaking the other day, said he had reason to think that orders for 100 trawlers would be placed by local owners, once they were assured of the dock accommodation. Even if only fifty new vessels were built, he pointed out, that would mean regular work for 500 fishermen in the crews, and 1500 men on shore.

Smokeless Fuel Progress.

At the opening of Coalite House, Grosvenor-place, London, the new headquarters of Low-temperature Carbonisation, Ltd., Colonel W. A. Bristow, managing director, made some interesting statements with regard to the position and prospects of the company. He said that at Barugh, near Barnsley, they now had 160 cast iron retorts, in which they distilled 1750 tons of coal per week. Although the plant had been working night and day, seven days a week, for eighteen months, it was quite inadequate to meet the demands made upon it, and they were 1700 trucks of Coalite in arrear. The new plant at Askern Colliery, near Doncaster, was nearing completion. It would be brought into operation in March, and would have an output of 600 tons per day. He also announced the acquisition of a site on the Thames for a low-temperature carbonisation works.

Municipal Schemes.

Important works of public improvement are in prospect at the seaside resorts of Bridlington and Whitley Bay. At Bridlington a Ministry of Health inquiry has been held with regard to the Corporation's application for power to borrow £50,290 for the construction of a sea wall, promenade, and shelter accommodation on the north foreshore. The new wall will be 1300ft. long, and will be a continuation of the strong wall erected about fifty years ago. The Whitley Bay scheme, which has also been the subject of an inquiry, contemplates the expenditure of £67,100 on the construction of a southern promenade and sea wall.

NORTH OF ENGLAND.

(From our own Correspondent.)

Brighter Trade Conditions.

QUITE an optimistic tone prevails in iron and steel trade circles in the North of England. Signs are not lacking that the long years of trade depression have been left behind, and that a new and better era is being entered upon. Considerable progress, it is true, has yet to be made before anything like a normal state of activity is reached, but conditions generally are moving in the right direction, and there is every indication that the improvement which has been noted during the past three or four months will continue to expand. There is certainly more confidence abroad, and this is all to the benefit of industry. Producers of iron and steel have no longer to contend with keen continental competition, as manufacturers abroad are well sold, and in most cases are unable to enter into new contracts except for delivery well ahead. In addition, working expenses of foreign firms have moved up, and there is a threatened further increase in expenses, while cost of production in this area has eased and is expected to be still easier as the result of the de-rating scheme.

Cleveland Iron Trade.

The Cleveland iron trade at the moment is characterised by conditions of marked stringency. Indeed, a striking feature of the situation is the arrival of iron in the district from the Midlands, to help to cope with the heavy absorption at local works. The fact is that there has been a much more active sale of pig iron since the beginning of the year, and local firms are using such a large proportion of their make in their own steel furnaces that there is only a very limited surplus to meet the general market requirements. To meet the situation two additional furnaces are to be put into operation, one at the Newport Ironworks and the other at the Redcar Ironworks. Scottish consumers, who have been taking Midland iron for some months past owing to its cheapness, are now moving for supplies in the Cleveland market, and a few parcels have been sold to consumers north of the Tweed. One or two export transactions are also reported. Under such circumstances prices are very firm, No. 1 Cleveland foundry iron being 68s. 6d. ; No. 3 G.M.B., 66s. ; No. 4 foundry, 65s. ; and No. 4 forge, 64s. 6d.

Hematite Pig Iron.

East Coast hematite pig iron sales to home and overseas consumers promptly absorb the output, and makers have virtually no stocks to draw upon. Export inquiries are expanding, and sales for dispatch to customers abroad would be larger if more iron were available for prompt delivery. Terms of sale vary little, though makers are not bound by any arrangements as to quotations. Ordinary qualities are obtainable at 71s., and that may be taken as the basis of market rates.

Ironmaking Materials.

Transactions in foreign ore are few and small, buyers and sellers' ideas of values being still rather wide apart. Merchants do not name below the equivalent of 22s. 6d. c.i.f. Tees for best Rubio, but consumers are very disinclined to renew contracts at the figures asked. Supplies of coke are barely sufficient to the needs of the trade, and 17s. 9d. is now a firm quotation for good Durham furnace qualities.

Manufactured Iron and Steel.

The tone of the manufactured iron and steel trade generally is remarkably healthy. Conditions are gradually changing for the better, and the opinion prevails that a period of good trade has at last been entered upon. Considerable inquiries for steel for the Far East are circulating. Foreign competition is declining, and British makers have experienced such a heavy demand for semi-manufactured material that they have advanced prices. Medium steel billets, which were £6 7s. 6d., are now up to £7 5s., and hard billets have advanced from £7 12s. 6d. to £7 15s. per ton. The only other change is that steel rivets have been advanced 5s. to £11 5s. per ton.

The Coal Trade.

The Northern coal trade maintains a very favourable tendency, and, with odd exceptions, the undertone is decidedly firm, and is causing buyers to show some anxiety as to the forward trend of the market. Many operators now regret their policy of holding off in December when they could have covered almost all descriptions at values substantially below current prices. Under the present scale of production all the favourite qualities are sold to the end of February, and some merchants are having to cover in other centres. The demand for Northumberland steam coals is so insistent that in a few instances collieries are obtaining as much as 2s. per ton more than they were able to get last autumn, and many of them are enjoying the benefit of a shilling advance. Secondary gas and coking coals have improved about ninepence, and other classes have appreciated less but are very firm. Steam smalls are not doing so well as large, but producers have nothing to complain about, as stocks are down to manageable proportions, with more business to follow. Gas coals are in full seasonal request, and it is a long while since there were such large inquiries for coking and bunker fuel. The coke trade is irregular, but, on the whole, stocks are ample to meet all demands, and are offered freely at recent prices. Gas coke is about 18s. 6d. ; patent oven cokes, 18s. to 18s. 6d. ; beehive and other superior makes, 23s. 6d. to 28s. 6d.

SCOTLAND.

(From our own Correspondent.)

Steel.

STEELMAKERS have nothing of outstanding importance to report. Employment is still somewhat irregular, the position at the works varying according to the class of material turned out. Makers of heavy steel are, on the whole, better employed, and recently there has been a slightly better demand for sections. Producers generally continue to anticipate an improvement in trade in view of the better outlook in the shipbuilding industry and the advancing tendency of continental prices of competitive material.

Steel Sheets.

Steel sheet makers have a fair turnover in light gauges, but are doing very little in heavy sheets. Galvanised flat and corrugated sheets have a moderate turnover.

Tubes.

Most of the tube works are busy, but more particularly those engaged in the production of the hot rolled descriptions.

Bar Iron.

The bar iron trade continues without any sign of improvement. The steel re-rolling department, too, is not now so busy, owing partly to the fact that considerable quantities of continental materials are being consumed locally. Re-rolled steel bars are still quoted £7 15s. home and £7 10s. to £7 15s. per ton export.

Exports and Imports.

During the past week 7000 tons of iron ore and 1800 tons of steel and iron were unloaded at Glasgow Harbour. Shipments of steel and iron amounted to 4800 tons and pig iron to 731 tons.

Iron Trade Dispute.

Owing to the posting of notices by employers intimating their intention to negotiate conditions separately

at the works instead of through the machinery of the Conciliation Board, 1500 men in the manufactured iron trade in Lanarkshire have ceased work. The men consider that the proposed conditions would mean an increase in the working week from 40 to 47½ hours, without any extra payment. The men offered to take the question at issue to arbitration, but the employers implicated would not agree to arbitration on hours. Replying to the secretary of the Iron and Steel Trades Confederation, Mr. J. C. Bishop, the secretary of the Scottish Iron Manufacturers' Association, said: "In view of the state to which the wrought iron industry in Scotland has been brought, of which the figures of the audit tonnage are evidence, showing as they do a decline to about 25 per cent. of the pre-war tonnage, a decline which still continues, and looking to the impracticability of carrying on the trade in the ragged and spasmodic manner which has recently been the case, it is necessary to have a two-shift system of working, with reduced costs in forges and mills producing wrought iron. The employers have the strongest conviction that the issue is whether the industry will practically cease in Scotland or will take immediate steps to effect an improvement in the position which would secure the employment of the men presently employed, and hold out some hope of re-employment for those out of work." Two of the largest firms, however—Messrs. David Colville and Sons and Messrs. Smith and M'Leans, Clydesdale Works—have refused to terminate the national agreement, and work proceeds there as usual.

Coal.

Conditions in the coal market are unchanged on the week. Supplies of all classes of fuel are scarce, partly owing to a broadening out of the home demand due to the severe weather. Practically nothing, apart from very small parcels, is available for shipment under two weeks at the earliest, and in the case of Lanarkshire splints for a much longer period ahead. Aggregate shipments amounted to 239,164 tons, against 221,697 tons in the preceding week, and 226,525 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THE position in the coal trade continues to be satisfactory, inasmuch as collieries are working well, and for the next fortnight at least their production is practically fully booked up. A number of undertakings have full order books for the whole of February, and, fortunately for most collieries, the position is that there is not a shortage of ready tonnage, as the docks are well supplied. The beginning of this week showed that only five tips at the leading ports in this Channel were unoccupied, and on Tuesday there were ten tips idle, while there were five steamers waiting their turn to load. Certainly chartering has not been quite as active of late as was the case a week or so ago, but this is due to the fact that owing to the tightness of stems, owners have sent their tonnage elsewhere, though it should be pointed out that the loading conditions on the North-East Coast and at continental ports are no better than in South Wales at the moment, and a certain amount of congestion appears to prevail at all export centres. Coal market conditions are firm for all descriptions, and very few collieries have any coal to dispose of. Higher prices are being quoted in some directions, as will be seen from the fact that for best qualities of smalls some salesmen are asking up to 14s., while for Monmouthshire large coals they are quoting up to 19s., which is little short of the figure for best Admiralty large coals. The question is being debated in some quarters whether collieries are not rather overdoing it, and as the result of asking higher prices driving business to other coalfields. It is stated in market circles that a number of orders are waiting to be placed, but that buyers are for the moment holding their hands, and are refusing to pay the prices which some collieries are demanding. It is a pity that any business should be lost to this district. Although the immediate position may be good, collieries should not imagine that they can ask any price and display independence, as competition from abroad is still keen, and the position may quickly change. The fact that some collieries are employing more labour, and that production may be increased is a matter of no little importance, and, as is well known, it requires very little extra production to have a material influence upon general market conditions. Shipments are undoubtedly good, and hopes are entertained that they will continue. Last week the total came to over 485,000 tons, which compared with rather more than 418,000 tons the previous week. Although the tonnage situation at the moment may be pretty well equal to requirements, the fact cannot be denied that owing to the long loading hours which collieries have recently been asking for, many owners have been sending their steamers away in ballast. This applies more especially to the large-sized vessels, which are more than ordinarily useful. There are many orders held for cargoes ranging from 5000 to 9000 tons, but tonnage of this size is not offered at all plentifully on the market. As regards new business, news is awaited regarding the requirements of the French Marine, which amount to about 50,000 tons for shipment by August 1st. The order for about a similar quantity of superior Admiralty large coals for the Navagazione Generale Italiana, the well-known shipping company of Italy, has now been given to one of the leading combines in this district, while news has been received from Cairo that the Egyptian State Railways have allocated their contract for 200,000 metric tons of locomotive coals for delivery from now to May next at Alexandria. Of the total mentioned, 70,000 tons goes to T. Beynon and Co., whose price was 28s. 5¼d. per ton c.i.f., and the remainder of 130,000 tons is secured by Watts, Watts and Co., whose quotation was 28s. 6d. per ton c.i.f. Alexandria.

Docks Working Hours.

Reference was made recently to the efforts for extending the loading facilities at South Wales ports, and the negotiations which were proceeding with the trimmers for working overtime. The need for doing something in this direction has been emphasised, owing to the competition of other exporting centres; but, unfortunately, it does not look as if the employers are going to get far with their proposals, as the trimmers, both at Cardiff and Barry, on Sunday last decided to oppose most strenuously the suggestions put before them. Mass meetings of the men were held, when they declared their uncompromising opposition to any extension of the present eight-hour day. They state that they are convinced that the requirements of the ports and trade can be maintained by the readoption of the two continuous shifts, with the addition of an extra three-hour shift when required. Hopes are entertained that some means will be found to arrive at an agreement, whereby extra work can be done when the necessities of trade warrant it.

Wages in Steel Trade.

There is to be no change for the time being in the wages at works in the Siemens Steel Association. The ascertained selling price of steel bars which governs wages for the quarter ended December 31st last, has been returned at £5 14s. 7·66d., as compared with £5 14s. 8·64d. for the preceding ascertainment. The present ascertainment governs wages for the period February 3rd to May 5th. Many of the workers governed by the sliding scale are at present receiving certain *ex-gratia* payments, the continuance of which is understood to be a question for negotiation.

Tin-plate Development.

It is reported that an interesting development in the tin-plate industry at Llanelly is the manufacture of metal packing cases for tin-plate. This was recently begun at premises of the Burry Tin-plate Works, which have been leased from Richard Thomas and Co. It is stated that a number of local tin-plate manufacturers are behind the scheme, which is likely to show considerable development as the tin-plate trade improves. The boxes are made of terne sheets which are used for the packing of tin-plates for export purposes only.

Good Clean Coal.

It is generally recognised that one of the best ways to get foreign custom for Welsh coals and keep it, is to improve the way in which coals are delivered to buyers. Good clean coal is what buyers want, and this is a matter which has been receiving considerable attention in this district of late. It is therefore interesting to see that the Great Western Railway Company is erecting at the King's Dock, Swansea, a new appliance to prevent the breakage of coal during shipment, and the result of its operation will be watched with considerable interest. According to an official statement, the Great Western Company has for some time past recognised the urgent need for an improved method of shipping coal which will still further lessen breakage, and at the same time ship the coal more expeditiously. With this object in view, a new anti-breakage device of the conveyor type is at present being fitted to one of the modern 30-ton hoists at Swansea for experimental purposes, and it is understood that tests will shortly be made. The new apparatus weighs when loaded about 7½ tons, and is designed for suspension from the existing cranes provided at the coal hoists which handle the existing anti-breakage box. The arrangements provide for the new device to be brought against the point of the chute attached to the coal hoist, and the coal will be released by means of the wing doors in the chute on to a series of trays enclosed in a cylinder and placed on the bottom of the ship. After the coal is released from a plate or tray, the tray continues in a vertical position on the belt outside the cylinder until it reaches the top of the apparatus, when it immediately falls into a position in the cylinder ready to receive more coal. The speed of the belt is controlled by means of a centrifugal brake.

Coal Market.

The tone of the market for practically all descriptions continues to be firm. Best Admiralty large qualities are quoted at 19s. 3d. to 19s. 6d., while second qualities and leading Monmouthshire descriptions are close behind them at round about 19s. Small coals are especially tight, and salesmen are asking up to 14s. for any small parcels which they can spare for early loading. There is practically no change so far as coke and patent fuel are concerned, but pitwood is weak about 26s.

LAUNCHES AND TRIAL TRIPS.

PRESIDENT DAL PIAZ, twin-screw steel steamer; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of La Compagnie Générale Transatlantique, of Paris; dimensions, 377ft. 6in. by 52ft. 8in.; to carry passengers. Engines, twin-screw single-reduction geared turbines of the Parsons type; launch, recently.

BRITISH CHIVALRY, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Ltd., to the order of British Tanker Company, Ltd.; to carry 10,000 tons deadweight. Engines, quadruple-expansion; constructed by the builders; launch, January 24th.

HIGHLAND HOPE, twin-screw motor ship; built by Harland and Wolff, Ltd., to the order of H. and W. Nelson, Ltd.; dimensions, 520ft. by 69ft. by 35ft. 9in.; to carry cargo and passengers. Engines, two eight-cylinder double-acting four-cycle motor engines of the Harland-B. and W. type; constructed by the builders; launch, January 24th.

SUECIA, steamship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Swedish Lloyd Steamship Company, of Gothenburg; dimensions, 376ft. by 50ft.; to carry passengers. Engines, single-screw Parsons steam turbines; launch, January 24th.

ULSTER MONARCH, twin-screw motor vessel; built by Harland and Wolff, Ltd., to the order of Belfast Steamship Company, Ltd.; dimensions, 345ft. by 46ft. by 19ft.; to carry 419 first-class and 86 third-class passengers. Engines, two ten-cylinder airless injection trunk type Diesel engines; constructed by the builders; launch, January 24th.

CARDIFF, twin-screw motor vessel; built by A. and J. Inglis, Ltd., to the order of Argentine Navigation Company (Nicolas Mihanovich), Ltd.; dimensions, 275ft. by 43ft. by 13ft. Engines, two six-cylinder four-stroke trunk-type Diesel engines; constructed by Harland and Wolff, Ltd.; launch, Friday, January 25th.

CALENDARS, DIARIES, &c., FOR 1929.

THOMPSON BROS., Gilmore Works, Gilmore-road, London, S.E. 13.—Wall calendar with monthly tear-off sheets.

WELBECSON PRESS, Ltd., 108–110, Clarendon-road, Holland Park, W. 11.—Wall calendar with monthly tear-off sheets.

J. E. DODSWORTH, 46, Croxted-road, S.E. 21.—Engineers' pocket diary.

MARTIN BROS. (MACHINERY), Ltd., Manchester.—Wall calendar with monthly tear-off sheets.

TAYLOR AND CHALLEN, Ltd., Derwent Works, Constitutional-hill Birmingham.—Wall calendar with daily change cards.

CONTRACTS.

SOLVENT PRODUCTS, Ltd., asks us to announce that it has ordered from the chemical factory of E. Merck, Darmstadt, Germany, a large plant for the production of absolute alcohol.

ALFRED HERBERT, Ltd., asks us to announce that its American licencee, the Riley Stoker Corporation, has received an order for four large "Atritor" unit pulverisers for firing the boiler plant for the New Yorker Hotel, which is being built in Broadway, New York City.

THE GENERAL ELECTRIC COMPANY, Ltd., has received orders from (*a*) H.M. Admiralty for part of the latter's requirements in Osram gas-filled and vacuum lamps, also for Robertson carbon lamps; and (*b*) the Port of London Authority for six months' requirements of Osram gas-filled and vacuum lamps.

DE HAVILLAND AIRCRAFT OF CANADA, Ltd., has received an order from the Canadian Department of National Defence for thirty-four "Moth" light airplanes, twenty-eight of which are to be land planes for re-equipping the Camp Borden station of the Royal Canadian Air Force, and the remainder to be sea-planes for the Government's flying station at Vancouver.

THE D.P. BATTERY COMPANY, Ltd., of Bakewell, Derbyshire, has received the following orders:—(*a*) From the British Broadcasting Corporation for a battery of 115 cells with a capacity of 1950 ampère hours for the Regional Station to be erected at Brookmans Park, Potters Bar; and (*b*) from Messrs. Wingrove and Rogers and Greenwood and Batley, Ltd., for a total to date of fifty-two Kathanode batteries, for use in operating locomotives on the Mersey Tunnel excavation works.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. H. WARREN LEE has been appointed a special director at the Elswick Works of Vickers-Armstrongs, Ltd.

MR. W. PARKER, M. Inst. C.E., M.I.E.E., late sales manager of British Furnaces, Ltd., has joined the staff of Premix Gas Plants, Ltd., York Mansions, Petty France, S.W. 1, as its sales engineer, as from February 1st.

THE BRAND POWDERED FUEL SYSTEM, Ltd., of York Mansions, Petty France, London, S.W. 1, asks us to announce that Engineer-Rear-Admiral J. W. Milner, R.N. (ret.), has become associated with that company; that Mr. W. H. Woolnough, M.I.N.A., M.I. Ma. E., of Messrs. Woolnough, Graham and Robb, naval architects, has been appointed general manager, with intimate control of the Marine Department; and that Mr. W. H. Portas, for many years plant and equipment engineer for Fuller Lehigh, Ltd., and Messrs. B. P. Sexton and Co., has assumed charge, under the board, of its metallurgical furnace, cement and kiln department.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION.—The Association has arranged to hold a dance on Tuesday, March 5th, at the Victoria Halls, Southampton-row (opposite Faraday House). Application for tickets should be made to the hon. secretary, Faraday House O.S.A., Southampton-row, W.C. 1.

FARADAY MEDAL.—The Council of the Institution of Electrical Engineers has made the eighth award of the Faraday Medal to Signor Guido Semenza, of Milan. The Faraday Medal is awarded by the Council of the Institution not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence, or membership of the Institution. Mr. Semenza has for many years taken a leading part in the development of the applications of electricity.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meetings of the Institution will take place on Wednesday, March 20th, and the two following days, in the Leteure Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. The annual dinner will be given on Wednesday, March 20th, at 7.30 p.m., in the Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, W.C. The Council of the Institution has awarded the following premiums for the year 1928:—One to Lieut.-Colonel V. C. Richmond, for his paper on "Some Modern Developments in Rigid Airship Construction;" and a joint premium to Mr. E. Leslie Champness and Mr. Frank McAlister, for their paper "Further Notes on the Relative Strength of Fine and Full Cargo Vessels." The premiums will be presented on March 20th next at the opening of the annual general meetings.

AMALGAMATION OF ELECTRICAL FIRMS.—The amalgamation of two of the oldest established firms of electrical engineers is now in process of completion, viz., Laurence, Scott and Co., Ltd., Norwich, and Electromotors, Ltd., Openshaw, Manchester, under the title—subject to the approval of the Board of Trade—of Laurence, Scott and Electromotors, Ltd. Laurence, Scott and Co. were established in 1883 and have a wide range of products, embracing large generating units with a corresponding range of motors. Electromotors, Ltd., was established in 1899 and has a well-equipped works for the manufacture of a specialised range of direct-current and alternating-current machines up to 150 horse-power. It also makes a special range of motors for driving ships' auxiliaries. The fundamental idea of the amalgamation is the elimination of redundant output; the concentration in each works of the class of machinery for which it is best adapted; the combination of buying and selling as well as of technical skill in the advancement of methods of manufacture and increase of output. The board of directors includes Mr. C. Wilson, chairman; Mr. W. H. Scott, founder of Laurence, Scott and Co.; and Sir Benjamin Longbottom, Electromotors, Ltd. The total capital of the business is £311,000.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	17/6 to 19/-
(1) Spanish	21/-
(1) N. African	21/-
N.E. COAST—	
Native	18/- to 21/-
Foreign (c.i.f.)	22/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 15 0	—
No. 1 Foundry	3 15 0 to 3 16 0	—
No. 3 Foundry	3 10 0 to 3 11 0	—
N.E. COAST—		
Hematite Mixed Nos.	3 11 0	3 11 0
No. 1	3 12 0	3 12 0
Cleveland—		
No. 1	3 8 6	3 8 6
Silicious Iron	3 8 6	3 8 6
No. 3 G.M.B.	3 6 0	3 6 0
No. 4 Foundry	3 5 0	3 5 0
No. 4 Forge	3 4 6	3 4 6
Mottled	3 4 0	3 4 0
White	3 4 0	3 4 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
,, ,, Foundry	3 5 0*	—
(3) Northampton—		
Foundry No. 3	2 17 6*	—
Forge	2 14 0*	—
(3) Derbyshire—		
No. 3 Foundry	3 2 6*	—
Forge	2 18 6*	—
(3) Lincolnshire—		
No. 3 Foundry	3 0 6	—
No. 4 Forge	2 17 6	—
Basic	3 0 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 0 0 (*a*); 4 3 6 (*b*); 4 6 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 5 0	—
Common Bars	10 5 0	—
Best Bars	10 15 0	—
Double Best Bars	11 5 0	—
Treble Best Bars	11 15 0	—
LANCS.—		
Crown Bars	10 0 0	—
Second Quality Bars	9 10 0	—
Hoops	13 0 0	—
S. YORKS.—		
Crown Bars	10 10 0	—
Best Bars	11 0 0	—
Hoops	12 10 0	—
MIDLANDS—		
Crown Bars	9 2 6 to 10 0 0	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 10 0 to 8 17 6	—
Gas Tube Strip	10 12 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	10 10 0	10 10 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	7 17 6	7 2 6
Steel Sheets, ¼in.	8 15 0	8 12 6
Sheets (Gal. Cor. 24 B.G.)	13 10 0 .. 13 12 6 to 13 15 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 7 6	—
Angles	7 17 6	—
Boiler Plates	12 15 0	—
Joists	7 17 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	7 15 0	—
Soft Billets	6 15 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0	—
Light Rails	8 5 0 to 8 10 0	—
Billets	6 15 0 to 9 10 0	—
MANCHESTER—		
Bars (Round)	8 17 6	—
,, (Small Round)	8 0 0 to 8 2 6	—
Hoops (Baling)	10 0 0	9 15 0
,, (Soft Steel)	9 0 0	8 15 0
Plates	8 12 6 to 8 17 6	—
,, (Lancs. Boiler)	9 12 6 to 9 17 6	—
SHEFFIELD—		
Siemens Acid Billets	8 15 0 to 9 0 0	—
Hard Basic	8 15 0	—
Intermediate Basic	7 5 0 to 7 15 0	—
Soft Basic	6 12 6 to 6 15 0	—
Hoops	9 5 0 to 9 10 0	—
Soft Wire Rods	7 15 0	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 0 0	—
Billets and Sheet Bars	6 2 6 to 6 5 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	13 12 6 to 13 15 0	—
Angles	7 17 6	—
Joists	7 17 6	—
Tees	8 17 6	—
Bridge and Tank Plates	8 12 6	—
Boiler Plates	9 15 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	18/- to 18/3
Block Tin (cash)	220 5 0
,, ,, (three months)	221 2 6
Copper (cash)	77 2 6
,, (three months)	74 12 6
Spanish Lead (cash)	22 2 6
,, ,, (three months)	22 3 9
Spelter (cash)	26 0 0
,, (three months)	26 0 0
MANCHESTER—	
Copper, Best Selected Ingots	79 10 0
,, Electrolytic	80 10 0
,, Strong Sheets	104 0 0
,, Tubes (Basis Price), lb.	0 1 2⅛
Brass Tubes (Basis Price), lb.	0 1 0⅛
,, Condenser, lb.	0 1 2½
Lead, English	23 12 6
,, Foreign	22 7 6
Spelter	26 5 0
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 10 0	7/6
,, ,, 6 p.c. to 8 p.c.	£20 10 0	7/-
,, ,, 8 p.c. to 10 p.c.	£20 0 0	6/-
,, ,, Specially refined		
,, ,, Max. 2 p.c. carbon	£33 0 0	12/-
,, ,, ,, 1 p.c. carbon	£37 0 0	15/-
,, ,, ,, 0·70 p.c. carbon	£42 0 0	17/-
,, ,, ,, carbon free	1/- per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£19 0 0 scale 6/- per unit	
,, Vanadium	14/- per lb.	
,, Molybdenum	4/3 per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£170 to £175	
Ferro-Cobalt	9/- per lb.	

FUELS.

SCOTLAND.
(*Prices not stable.*)

	Export
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/6
,, ,, Ell	17/-
,, ,, Splint	17/- to 18/-
,, ,, Trebles	15/6
,, ,, Doubles	13/6 to 13/9
,, ,, Singles	13/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	14/-
,, ,, Jewel	16/6
,, ,, Trebles	16/-
FIFESHIRE—	
f.o.b. Methil or Burnt-island—Steam	13/3 to 14/6
Screened Navigation	18/-
Trebles	15/6 to 16/-
Doubles	14/-
Singles	12/9 to 13/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/-
Secondary Steam	13/6
Trebles	15/- to 15/6
Doubles	14/- to 14/3
Singles	12/9 to 13/-

ENGLAND.

(8) N.W. COAST—	
Steams	23/-
Household	38/6 to 51/-
Coke	22/-
NORTHUMBERLAND—	
Best Steams	14/6
Second Steams	13/9 to 14/-
Steam Smalls	9/-
Unscreened	12/- to 12/6
Household	21/- to 27/-
DURHAM—	
Best Gas	14/9
Second	13/9 to 14/3
Household	21/- to 27/-
Foundry Coke	18/- to 19/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	26/- to 27/6 —
Derbyshire Best Bright House	22/6 to 24/- —
Best House Coal	20/6 to 21/6 —
Screened House Coal	17/- to 18/- —
,, ,, Nuts	16/- to 18/- —
Yorkshire Hards	15/- to 16/- —
Derbyshire Hards	15/- to 16/- —
Rough Slacks	8/6 to 9/6 —
Nutty Slacks	4/6 to 6/- —
Smalls	3/6 to 4/- —
Blast-furnace Coke (Inland)	14/6 at ovens —
Furnace and Foundry Coke (Export), f.o.b.	19/- to 19/6

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	19/3 to 19/6
Second Smokeless Large	19/- to 19/3
Best Dry Large	18/6 to 19/-
Ordinary Dry Large	18/- to 18/6
Best Black Vein Large	18/9 to 19/3
Western Valley Large	18/6 to 19/-
Best Eastern Valley Large	17/6 to 18/3
Ordinary Eastern Valley Large	17/- to 17/6
Best Steam Smalls	13/6 to 14/-
Ordinary Smalls	12/- to 13/-
Washed Nuts	18/- to 24/-
No. 3 Rhondda Large	20/6 to 21/6
,, ,, Smalls	14/6 to 16/-
No. 2 ,, Large	17/6 to 18/-
,, ,, Through	16/- to 17/-
,, ,, Smalls	12/6 to 13/6
Foundry Coke (export)	27/- to 37/-
Furnace Coke (export)	19/- to 21/-
Patent Fuel	20/- to 21/6
Pitwood (ex ship)	25/9 to 26/3
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	33/- to 35/-
Seconds	25/- to 29/-
Red Vein	22/- to 27/-
Machine-made Cobbles	40/- to 43/6
Nuts	36/- to 43/6
Beans	23/6 to 25/-
Peas	16/6 to 17/6
Breaker Duff	8/9 to 9/3
Rubbly Culm	9/- to 9/6
Steam Coals:	
Large	17/6 to 18/6
Seconds	16/- to 17/-
Smalls	9/6 to 12/-
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.t. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate 12/6 joists and 10/- all other materials if home consumers confine purchases solely to British products
* General quotation not necessarily recognised by market.

French Engineering Notes.

(From our own Correspondent in Paris.)

Industrial Progress.

THE figures of pig iron and raw steel production in 1928 show that there was continuous progress during the year. The quantity of pig iron produced was 10,097,000 tons, an increase on the previous year of 771,000 tons, while the output of raw steel was 9,387,000 tons, an augmentation of 1,081,000 tons. The number of furnaces in blast in December last was 153, or nine more than at the beginning of 1928. This progress, which was fairly steady, is the more noteworthy because there were periods during the year when the situation was far from satisfactory, but prices all round are now appreciably higher than they were a year ago, and considerably more metal is going into consumption. It is stated that higher prices are also applied to the export trade, but that is not borne out by the foreign trade returns for 1928. This decrease cannot be attributed to the monetary depreciation, because the franc was practically stabilised over nearly the whole of that period. On the face of it, the foreign trade returns appear unfavourable, since there is a considerable increase of imports over exports, but that is not altogether a disadvantage. The increase of imports was due entirely to manufactured goods, the value of which augmented by 2122 million francs. Those goods were supplied largely by Germany on account of reparations, and, while included in the Customs' returns, they were paid for to the French State, so that no money left the country. Moreover, all the goods in the form of machinery, plant and material are being employed for purposes which will increase the country's productive capacity. Apart from this, the adverse balance upon which so much comment is made is due to a declension in the values of exports of "material necessary for industry." The total value of imports is estimated at 53,448 million francs, an increase on 1927 of 398 million francs, and the exports were valued at 51,346 million francs, a decline on the year of 3577 million francs.

Bridge Building.

In the construction of reinforced concrete bridges, designs are following those of metallic bridges, both of the bowstring and the girder types, and the attempts to convey the same impression of lightness have, to a large extent, succeeded. By the use of steel rods of sufficiently high tensile strength, it has been found possible to reduce sections and give a lighter appearance to the structure. The new bridge of 410ft. span now being completed over the Seine at Conflans-Ste Honorine, is a good example of the way in which modern concrete bridge design follows orthodox lines. By far the longest concrete bridge yet constructed in France, that being built across the estuary of the Elorn between Brest and Plougastel, is well advanced, the third span having recently been completed. Each span has a length of 590ft., and the total length of the bridge, including the concrete approaches, is 1330 yards. It will have two decks, the lower for the railway and the upper for the tramways and the road. Another work to be undertaken very shortly is the widening of the Pont de la Concorde in Paris, which, it is expected, will be put in hand almost at once. The bridge was built in 1787 with a width of 14·75 m., which is now wholly insufficient, and at the time of the Decorative Arts Exhibition footways had to be built each side. It is intended to widen the bridge to 35 m. The next undertaking will be the reconstruction of the Pont de l'Alma, which is not only insufficient for the traffic but is an obstacle to navigation.

Coal in Morocco.

Some time ago an official statement was issued to the effect that phenomenal deposits of coal had been discovered in Madagascar, but since then nothing further has been heard about the existence of fuel resources that might have been expected to arouse widespread interest. Now a further coal discovery is said to have been made in Morocco, where coal seams are alleged to have been found over a wide area between Oudjda and Figuig. At one place a seam, 5ft. thick, has been discovered near the surface, while another deposit, 2ft. thick, appears to extend over an area 10 miles long and 3 miles wide. Permission to prospect for coal over this region has been granted to a Belgian company.

Industrial Organisation.

In a general way it may be said that the industrial situation is more hopeful than it has been for a long while past. There is plenty of employment, and in many directions business is brisk. Nevertheless, it is felt that there are difficulties in the way, and they were referred to by Monsieur Cuvelette, managing director of the Mines de Lens, in an address before the Société Industrielle du Nord de la France. The crisis in Western Europe, he said, was due to the creation of numerous factories during the war, to a more active research for new methods and processes, to profound economic changes and to a general over-production. The only way to save the industry was to adopt a system of rationalisation, secure the collaboration of labour and carry out social works, and when that was done, it would be necessary to organise a collaboration of all the industrial groups, which are really dependent upon each other.

"Revue de Metallurgie."

The holding of a banquet on the occasion of the twenty-fifth anniversary of the *Revue de Métallurgie* was of more significance than is usually attached to celebrations of this kind, since it really marked the birth of the technical Press in France. Held at the club of the Anciens Elèves de l'Ecole Polytechnique, the banquet was attended by many well-known metallurgists. Although the science of metallurgy had made great strides in France before 1900, there was, at that time, no periodical that collated the results of research work and helped it forward, and Professor Léon Guillet spoke of the valuable assistance rendered by Monsieur Le Chatelier in founding the *Revue de Métallurgie*. Monsieur Le Chatelier outlined possibilities in the way of the review being associated more directly with research work.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

302,802. December 19th, 1927.—JOINTS FOR CYLINDER COVERS OF INTERNAL-COMBUSTION ENGINES, Richardsons, Westgarth and Co., Ltd., and Walter Scott Burn, both of Hartlepool Engine Works, Hartlepool, Durham.

The cylinder cover joint described in this specification comprises an annular packing in contact with the cylinder liner, with the cylinder cover and with a ring spring-urged in an axial direction, the arrangement being such that the spring pressure holds the packing closely against the cylinder cover and the liner end at all times irrespective of expansions or contractions of the cylinder parts. A represents the outside end of a cylinder liner, B the associated part of the cylinder jacket, and C a portion of the cylinder cover which fits within the liner and is secured to the jacket B in any suitable way and by any appropriate means

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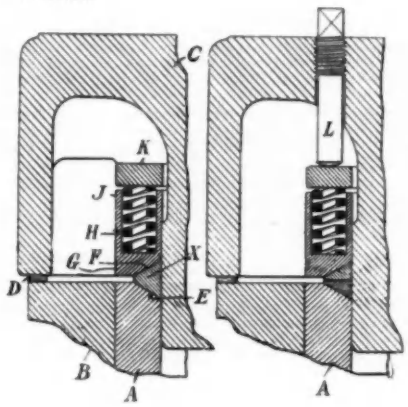

including a gasket D. In the example of the invention illustrated, a single packing ring X is employed, approximately triangular in cross-section, and preferably composed of a yielding material such as lead or other acid resisting metal or alloy, in solid or fibrous form. This wedge-shaped ring X is seated against corresponding wedge-shaped surfaces constituted respectively by the bevelled surface E of the inside edge of the liner A, and a similar bevelled surface F on a carrier ring G which closely fits the cylinder cover. The spring shown at H is one of a number housed in pockets J in the ring G, and adapted to react against a ring K. The springs H may be put in compression either by the tightening down of the cover as a whole or as shown on the right by means of a number of independent tap bolts L extending through the cover.—*December 27th*, 1928.

DYNAMOS AND MOTORS.

302,466. November 9th, 1927.—IMPROVEMENTS IN OR RELATING TO ELECTRIC MOTOR GENERATORS, George Herbert Fletcher, of 22, Glentilt-road, Ecclesall, Sheffield; Arnold Tustin, of 31, Broomhall-place, Sheffield; and Metropolitan-Vickers Electrical Company, Ltd., of 4, Central-buildings, Westminster.

The motor generator set described in this specification is designed to maintain a steady voltage, irrespective of the speed. It comprises a motor armature A, a generator armature B, a motor series field winding C, and a generator shunt field winding D. The terminals of the motor are connected to a source of supply the voltage of which may vary. The motor generator set may form, for instance, part of the equipment of an electric traction system, the generator supplying current to a load across the generator terminals E. In order that the voltage at the terminals E of the motor generator set may remain substantially constant, an auxiliary field winding G is provided on the motor

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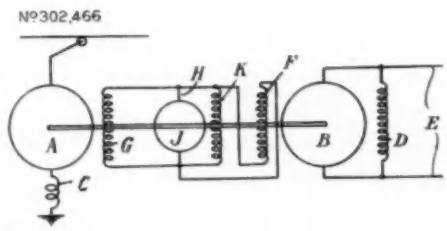

in addition to the motor series field winding C, and an auxiliary field winding F is provided on the generator in addition to the generator shunt field winding D. These auxiliary field windings are connected to an exciter machine H having an armature J and a shunt field winding K. The armature J of the exciter is mechanically coupled to the motor shaft. The armature J and the shunt field winding K of the exciter are arranged to be connected with the auxiliary motor and generator field windings G and F respectively in such a manner that the auxiliary field winding G of the motor, when energised by the exciter, assists the motor series field winding C, whilst the auxiliary generator field winding F, when energised by the exciter, opposes the generator shunt field winding D. In this manner the exciter is arranged to compensate the field excitation of the motor for variations in the supply voltage to the motor or in the load on the generator and in addition to compensate the field excitation of the generator for variations in speed.—*December 26th*, 1928.

302,473. November 21st, 1927.—EXCITATION OF SYNCHRONISED ASYNCHRONOUS MOTORS, *Stanley Gordon Sinclair Dicker, of 20–23, Holborn, London, E.C.* 1.

In the diagram the stator of an asynchronous motor is designated by A and the rotor winding by B. The former is supplied from a three-phase network at C. When the switch D is closed the machine operates as an asynchronous motor, which can be started by cutting out the resistances within the rotor circuit. As soon as the switch D is opened the rotor B can be excited with

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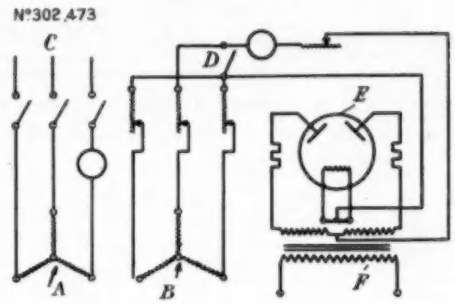

direct current from a two-phase rectifier E which is supplied with alternating current from a transformer F.—*December 20th*, 1928.

302,483. November 29th, 1927.—IMPROVEMENTS IN THE CONSTRUCTION OF DYNAMO-ELECTRIC MACHINES, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C. 2; Reginald Donahoe Ball and Henry Austin Brown, both of Siemens Works, Stafford.

In connection with the ventilation of dynamo-electric machines by the passage of air through ducts arranged in planes at right angles to the shaft in the core of the rotor or stator or both, it has been recognised that an advantageous effect can be produced by giving to the wedges which close the mouth of the slots an appropriate shape in those parts which extend across the ventilating ducts. This advantageous shaping of

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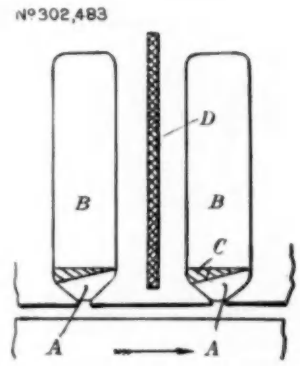

parts of the wedges has hitherto only been carried out in cases in which the slots are of the type known as open slots. This invention provides a construction which applies this advantageous form to wedges for use in the case of closed or partially closed slots. The rotor rotates in the direction shown by the arrow. The stator core has slots B closed by the wedges A. Spacers D determine the width of the ventilating duct. The slots are of the conventional semi-closed type. In order to obtain the necessary depth of radial surface the wedges A are made deep enough to fill a portion of the slots B where the sides are parallel. Where the wedges pass across the ducts the front portions are cut away so as to leave a triangular section C as shown.—*December 20th*, 1928.

SWITCHGEAR.

291,085. April 20th, 1928.—EXPLOSION PROOF HOUSING FOR ELECTRICAL APPARATUS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Assignees of Siemens-Schuckertwerke Gesellschaft mit beschrankter Haftung, of Berlin-Siemensstadt, Germany.

This specification describes an explosion proof housing for

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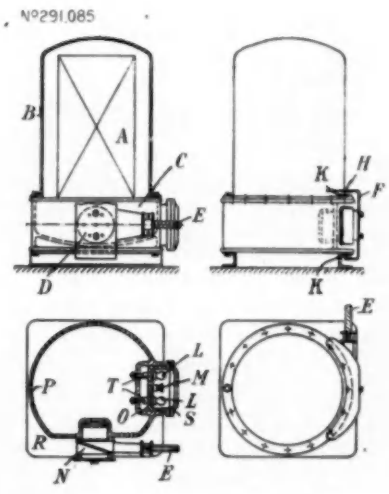

electrical apparatus consisting of a base part for the reception of the apparatus and of a hood, which covers over the apparatus and is connected to the base part in an explosion proof manner. The switching apparatus A, such as switches with magnetic and thermal overload releases, switching-in magnets, fuse, potential transformer and so on are fixed on a base-frame C. Over these switching apparatus a housing, for instance, a hood B of wrought

iron is placed, and is fixed and sealed in an explosion proof manner, to the base-frame C by means of a flange. The connections of the switching apparatus A, in the housing B, to the supply wires and to the apparatus to be controlled is effected by means of plug connections D and cable E. The plug connector D is provided with a part F, which, with its bent over extremities H, reaches over the fastening bolts K and only permits their being loosened, when the plug connector is completely withdrawn from the base-frame, that is when the various apparatus A are dead. The indicating device, such as the signal lamps L and fuses M, and the plug connector N for the switching apparatus, are accommodated in recesses O of the wall P of the base-frame R. The indicating devices are located in a separate housing S, and are connected through the plug T, by means of which an easy removal and insertion of the indicating device with its housing S is rendered possible.—*December 27th*, 1928.

MISCELLANEOUS.

292,953. June 19th, 1928.—IMPROVEMENTS IN OR RELATING TO WIND MOTORS, Société Anonyme pour l'Exploitation des Procédés Maurice Leblanc-Vickers, of 37, rue du Rocher, Paris 8E, France.

A wind-motor constructed according to this invention comprises the application of very fine sections for the wings or blades, presenting a very small ratio of the drag to the thrust, and owing to this feature the blades can be but very little inclined to the plane of rotation. They have a very small pitch with respect to the diameter, *i.e.*, less than a third of the diameter. The

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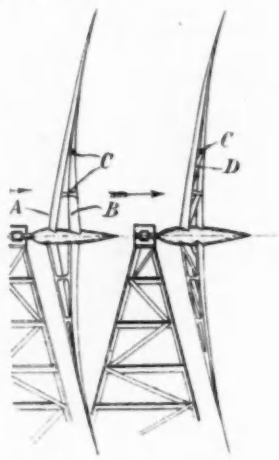

blades are made as shown in the illustrations. They consist of several aerofoils overlapping each other more or less in the direction of the axis of the impeller, so as to constitute, with respect to the thrust of the wind, a light and strong compound girder, which may comprise, in addition to the members A and B constituted by the aerofoils with stream-line section, struts C and braces D, which are also stream-lined to reduce resistance to forward movement. The blades are also turned back or inclined in the direction of the wind as shown in the drawings so as to compensate by the action of centrifugal force the bending force exerted by the wind.—*December 27th*, 1928.

302,824. January 26th, 1928.—IMPROVEMENTS IN AND RELATING TO SHOCK-ABSORBING DEVICES, The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, London, W.C. 2, Cecil James Morton, of "Amulree," St. Paul's-road, Coventry, and Thomas Henry Woodfield, of 85, Addison-road, King's Heath, Birmingham.

This invention relates to shock absorbing devices for incorporating in driving gearing so that sudden shocks or blows will not be transmitted from a driving member to a driven member through the gearing connecting them. The invention is more particularly applicable to a drive, such as occurs in combined magneto generators of the type now commonly used in motor bicycles to provide both the ignition current and the lighting current. On the driving shaft A there is a pair of discs B and C between which there is a driving member D of star shape. The discs and driving member are rigidly secured

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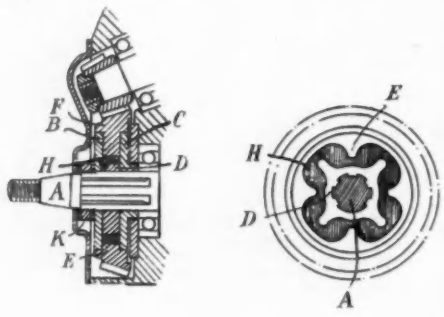

on the driving shaft. Mounted between the discs is the web E of the driving gear wheel F, which is recessed so that the peripheries of the discs B and C enter the recesses and hold it concentric with the shaft. The web has a central aperture which is shaped so as to have a considerable space between it and the driving member D. This space is filled with a resilient material H, such as rubber, and the torque of the driving member is transmitted through this material to the gear wheel. The web of the gear wheel is of slightly less thickness than the driving member, so that it can rotate relatively to the discs. The whole assembly is held in position on the shaft by means of a nut K screwed on the shaft and locked. This construction is compact and ensures protection of the resilient material against grease and oil. The gear wheel is well supported in a manner which will ensure of its being concentric with the driving shaft and at the same time provide the necessary bearing surfaces.—*December 27th*, 1928.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF ELECTRICAL ENGINEERS: METER AND INSTRUMENT SECTION.—At Savoy Place, London, W.C. 2. "Recent Developments in Electricity Meters, with Particular Reference to those for Special Purposes," by Mr. J. L. Carr. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Thomas Hawksley Lecture, "Engineering Principles in the Machinery of the Stars," by Professor A. S. Eddington, F.R.S. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. "Notes on Road Construction," by Mr. T. H. Cross. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Geometrical Art," by Professor J. L. Myres. 9 p.m.

SATURDAY, FEBRUARY 2ND.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—At the College of Technology, Sackville-street, Manchester. "Works Accounting and Foundry Practice," by Mr. J. O. Gray. 4.30 p.m.

MONDAY, FEBRUARY 4TH.

BRADFORD ENGINEERING SOCIETY.—Technical College, Bradford. "Economical Power from Process Steam by Means of Moderate-sized Steam Turbines," by Messrs. E. H. Marsh and A. J. H. Fitt. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: WESTERN CENTRE.—At the Merchant Venturers' Technical College, Unity-street, Bristol. "Coil Ignition," by Dr. F. W. Lanchester. 6.45 p.m.

RAILWAY CLUB.—57, Fetter-lane, London, E.C. 4. Annual general meeting, followed by presidential address. 7.30 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture. "The Treatment of Coal," by Dr. C. H. Lander. Lecture III. 8 p.m.

SOCIETY OF ENGINEERS.—In the Apartments of the Geological Society, Burlington House, W. 1 (entrance at the east end of the building in Piccadilly). "Berwick's Bridges," by Mr. A. Kirkwood Dodds. 6 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, Westminster, London, S.W. 1. "The Significance of the Timber Merchant in Estate Forestry," by Mr. H. J. Vaughan. 8 p.m.

TUESDAY, FEBRUARY 5TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Joint meeting with the Birmingham Metallurgical Society and the Staffordshire Iron and Steel Institute, in the Engineers' Club, Waterloo-street, Birmingham. "Electro-deposition," by Mr. D. J. Macnaughtan. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles," by Mr. H. Kerr Thomas. 7.45 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY GRADUATES.—At the Broadgate Café, Coventry. "Free Wheels," by Mr. R. A. Clapham. 7.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Ordinary meeting. Paper for discussion. "The Re-girdering of the Railway Bridge over the Krishna River, Madras, and Southern Mahratta Railway: Fourteen Spans of 150ft." by Mr. Harold Nugent Colam. 6 p.m.

WOLVERHAMPTON AND DISTRICT ENGINEERING SOCIETY.—The Star and Garter Hotel, Wolverhampton. "Electric Cranes," by Messrs. G. R. Adamson and C. F. Tinker. 7.30 p.m.

WEDNESDAY, FEBRUARY 6TH.

INSTITUTION OF CIVIL ENGINEERS: MANCHESTER AND DISTRICT ASSOCIATION.—Midland Hotel, Manchester. Annual dinner of the Association. 7 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. "The Development of the Oxide-coated Filament," by Dr. B. Hodgson and Messrs. L. S. Harley and O. S. Pratt. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Trueman Wood Lecture. "The Vibrations of Railway Bridges: An Example of Co-operative Research," by Sir J. A. Ewing, F.R.S. 8 p.m.

THURSDAY, FEBRUARY 7TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. "The Early History of X-rays," by Sir Wm. Bragg, F.R.S. 5.15 p.m.

BRITISH ASSOCIATION OF REFRIGERATION.—In the Hall of the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W. 1. "The Industrial Value of Technical Education," by Sir William B. Hardy, F.R.S. 5.30 p.m.

FRIDAY, FEBRUARY 8TH.

CHEMICAL ENGINEERING GROUP.—In the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. "The *Bêle* of Surface Energy in Chemical Engineering," by Professor W. E. Gibbs. 8 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—In the Non-ferrous Section of the Applied Science Department of the University, St. George's-square, Sheffield. "Some Recent Developments in Nickel Metallurgy," by Mr. W. T. Griffiths. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Queen's Hotel, Coventry. Annual dinner of the Coventry Graduates.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "The Profession of the Mechanical Engineer," special discussion introduced by Mr. L. A. Legros. 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, Westminster, S.W. 1. "Recent Developments in the Art of Oil Cracking," by Dr. A. E. Dunston. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Recent Problems of Rail Transport at Home and Abroad," by Mr. C. E. R. Sherrington. 9 p.m.

SATURDAY, FEBRUARY 9TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Annual dinner of the London Graduates at Les Gobelins Restaurant, Heddon-street, Regent-street, W. 1. 7 p.m.

MONDAY, FEBRUARY 11TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—At the Queen's Hotel, Birmingham. "Coil Ignition," by Dr. F. W. Lanchester. 7 p.m.

TUESDAY, FEBRUARY 12TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Lecture Room of the Municipal College, Burnley. "Some Aspects of Modern Foundry Practice," by Mr. Griffiths. 7.15 p.m.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower-hill, London, E. 1. "The Design and Construction of Electric Auxiliaries for Marine Service," by Mr. G. J. Scott. 6.30 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—In the Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-on-Tyne. "Metallurgy of Engineering," by Mr. J. E. Newson. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—General meeting at the Rover Sports Club, Albany-road, Coventry. "Coil Ignition," by Dr. F. W. Lanchester. 7.30 p.m.

WEDNESDAY, FEBRUARY 13TH.

ILLUMINATING ENGINEERING SOCIETY.—Trocadero Restaurant, Piccadilly, London, W. 1. Twentieth anniversary dinner. 7.30 p.m.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—In the Thomas' Café, High-street, Swansea. "Recent Developments in Rolling Metal Strip and Sheet," by Mr. J. E. Malam. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, Westminster, S.W. 1. Informal meeting. Subject for discussion. "Merits of Alternative Methods of Driving Auxiliaries in Modern Power Stations," by Mr. Harry Philip Gaze, M. Inst. C.E. 6 p.m.

THURSDAY, FEBRUARY 14TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—In the Rooms of the Society of Motor Manufacturers and Traders, Ltd., 83, Pall Mall, S.W. 1. "Some Present-day Metallurgical 'Tools' and Methods:" "The X-ray Spectrometer," by Dr. C. J. Smithells; "Quantitative Spectroscope Analysis," by Mr. S. V. Williams; "High Magnification Microscopy," by Mr. H. Wrighton; "Dilatometers," by Mr. W. E. Prytherch: "Preparation of Some Unusual Metallographic Specimens," by Mr. A. J. Murphy. 7.30 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Joint meeting with the Institution of Engineers and Shipbuilders and the Institute of British Foundrymen, in the Rooms of the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. "Alloys: Past, Present, and Future," by Dr. W. Rosenhain, F.R.S. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Joint meeting with the Royal Aeronautical Society at the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Air-cooled Engines in Service," by Mr. A. H. R. Fedden. 6.30 p.m.

FRIDAY, FEBRUARY 15TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Informal meeting. "Steam Storage," by Mr. E. G. Ritchie. 7.30 p.m.

MONDAY, FEBRUARY 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The Royal Technical College, Glasgow. "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles," by Mr. H. Kerr Thomas. 7.30 p.m.

MONDAY, FEBRUARY 18TH, TO FRIDAY, MARCH 1ST.

BRITISH INDUSTRIES FAIR.—White City, London, 10 a.m. to 8 p.m. daily; and Castle Bromwich, Birmingham, 10 a.m. to 6 p.m. daily.

TUESDAY, FEBRUARY 19TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Joint meeting with the Birmingham Metallurgical Society and the Staffordshire Iron and Steel Institute, in the Engineers' Club, Waterloo-street, Birmingham. "Fuel," by Mr. E. C. Evans. 7 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The Engineering and Scientific Club, Wolverhampton. "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles," by Mr. H. Kerr Thomas. 7.30 p.m.

WEDNESDAY, FEBRUARY 20TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Purification of Water," by Major T. H. Bishop. 8 p.m.

FRIDAY, FEBRUARY 22ND.

INSTITUTION OF LOCOMOTIVE ENGINEERS: NORTH-EASTERN CENTRE.—Hotel Metropole, Leeds. "Reduction of Weight in Rolling Stock," by Mr. G. H. Taylor. 7 p.m.

SATURDAY, FEBRUARY 23RD.

INSTITUTE OF BRITISH FOUNDRYMEN.—Grand Hotel, Manchester. Annual dinner.

WEDNESDAY, FEBRUARY 27TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Engineers' Club, Manchester. "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles," by Mr. H. Kerr Thomas. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Resins," by Mr. A. F. Suter. 8 p.m.

THURSDAY, FEBRUARY 28TH.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Joint meeting with the Birmingham Metallurgical Society and the Staffordshire Iron and Steel Institute, in the Engineers' Club, Waterloo-street, Birmingham. "Metallurgy and the Evolution of the Balance," by Mr. W. A. Benton. 7 p.m.

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Queen's Hotel, Birmingham. Annual dinner. 7 p.m.

MONDAY, MARCH 11TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Queen's Hotel, Birmingham. "Some Investigations into the Performance of Tubular Radiators for Motor Vehicles," by Mr. H. Kerr Thomas. 7 p.m.

FRIDAY, MARCH 22ND.

INSTITUTION OF LOCOMOTIVE ENGINEERS: NORTH-EASTERN CENTRE.—Hotel Metropole, Leeds. "Experiments on Buffer Springs," by Mr. T. Robson. 7 p.m.